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Author:
American Superpower Corporation
Title:
The 1930 award of the American Superpower...
Place:
[Dover]
Date:
[1930]

BUSINESS
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Am3

American superpower corporation.

The 1930 award of the American superpower corporation, in connection with the Bonbright prize essay contest of 1925; including the report of the judges and the winning essay, the formal announcement of which was made at the convention of the National electric light association, at San Francisco, California, on June 19, 1930. [Dover, Del., The American superpower corporation, °1930]

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(Continued on next card)

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BUSINESS
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American superpower corporation. The 1930 award of the American superpower corporation ... [°1930] (Card 2)

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tion.—The winning essay: Development of the electric light and power industry in the United States during the period 1920–1930, by R. B. Sleight.

1. Electric light plants—U. S. 2. Electric power-plants—U. S. I. Bonbright & company, inc. II. Sleight, Reuben Benjamin, 1889–1927. III. Title. IV. Title: Bonbright prize essay contest of 1925. V. Title: Award of the American superpower corporation.

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The 1930 AWARD of THE AMERICAN SUPER-POWER CORPORATION in connection with the BONBRIGHT PRIZE ESSAY CONTEST of 1925

The 1930 AWARD *of*

THE AMERICAN SUPERPOWER CORPORATION

The 1930 AWARD of THE AMERICAN SUPER-POWER CORPORATION

in connection with the

BONBRIGHT Prize Essay Contest of 1925

Including the Report of the Judges and the Winning Essay, the formal announcement of which was made at the CONVENTION of the NATIONAL ELECTRIC LIGHT ASSOCIATION, at SAN FRANCISCO, California, on June 19, 1930

F·O·R·E·W·O·R·D

THE BONBRIGHT PRIZES

PRIZES aggregating $10,000 were offered by Bonbright & Company, Incorporated, in the spring of 1925 for the best contemporary reviews and forecasts of the electric light and power industry, to be written in the form of an article summarizing the progress of the decade 1920-1930, and dated as of January 1, 1930. They were thus to be in effect a five years' review and a five years' forecast. The contest was open to all except the Board of Judges, in which capacity the Board of Directors of The American Superpower Corporation consented to act.

Four hundred and thirty-eight manuscripts were turned in prior to May 18th, the closing date of the competition. Decision was rendered by the Board of Judges on June 16th, and the winners of the twenty-three prizes were announced at the Convention of the National Electric Light Association in San Francisco, California, June 18, 1925, by the then President Franklin T. Griffith.

THE AMERICAN SUPERPOWER CORPORATION AWARD

When the Board of Directors of The American Superpower Corporation consented to act as Judges, the Board voted to supplement $10,000 in prizes given by Bonbright & Company, Incorporated, with an additional prize of $10,000, to be awarded to that contestant whose paper, reviewed again in 1930, should appear to have most nearly approximated the facts as they eventuate.

In accordance with this offer, the Board of Directors of The American Superpower Corporation have reviewed all of the papers submitted in 1925 and have awarded the one prize of $10,000 for the essay by:

REUBEN B. SLEIGHT

THE BOARD OF DIRECTORS
OF
THE AMERICAN SUPERPOWER CORPORATION
ACTING AS JUDGES

WILLIAM W. BODINE: Vice-President, *The United Gas Improvement Company.*
B. C. COBB: Chairman of the Board, *The Commonwealth & Southern Corporation.*
GEORGE E. HARDY: Director, *Consumers Power Company.*
ALFRED L. LOOMIS: Vice-President, *Bonbright & Company, Incorporated.*
T. B. MACAULAY*: President, *Sun Life Assurance Company of Canada.*
THOMAS N. MCCARTER: President, *Public Service Corporation of New Jersey.*
SIDNEY Z. MITCHELL: Chairman of the Board, *Electric Bond and Share Company.*
WILLIAM SPENCER MURRAY: *Murray & Flood, Engineers.*
GEORGE ROBERTS: *Winthrop, Stimson, Putnam & Roberts, Attorneys.*
HORACE S. SCARRITT, Vice-President, *Bonbright & Company, Incorporated.*
RICHARD SCHADDELEE*: Chairman of the Executive Committee, *The United Light and Power Company.*
RAY P. STEVENS: President, *American Electric Power Corporation.*
FRANCIS B. THORNE*: *Lindley & Company.*
LANDON K. THORNE: President, *Bonbright & Company, Incorporated.*
PERCY S. YOUNG: Vice-President, *Public Service Corporation of New Jersey.*

**Not Members of the Board of Directors in 1925.*

C O · N · T · E · N · T · S

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REPORT *of the*
BOARD OF JUDGES

Report of the

Board *of* Directors Acting as Judges

of the 1930 Award of The American Superpower Corporation

In March, 1925, Bonbright & Company, Incorporated, Investment Bankers, offered prizes aggregating $10,000 for the best contemporary reviews and forecasts of the electric light and power industry, to be written in the form of articles summarizing the progress of the decade in 1920-1930, and dated as of January 1, 1930. They were thus to be in effect reviews for five years and forecasts for five years.

The conditions provided that the articles should be written so as to conform to the following "Editorial Note:"

> *"This article by.....presents in a clear and concise manner the story of the electric industry during the past ten years. It covers briefly the field of power and light operations and traces the modifications and improvements in the generation, distribution and merchandising of electricity, as well as outlining the progress made in such important phases of the industry as public relations and financing methods. Written in terms intelligible to all who are interested in the industry, this article constitutes an absorbing story as well as an illuminating report."*

At the request of the donors of the Prizes, the Board of Directors of The American Superpower Corporation consented to act as Judges. At the time of accepting this invitation, the Board voted to supplement the $10,000 in prizes given by Bonbright & Company, Incorporated, with an additional Prize of $10,000. In announcing this resolution the Board said:

"The Board fully realizes the fact that to estimate the relative merit of varying forecasts is fraught with difficulty. With this in mind, and in order that more complete justice may be given to the competitor whose prophecies prove most accurate, it has authorized another Prize of $10,000 in the name of The American Superpower Corporation to be awarded to that contestant whose paper, reviewed again in 1930, shall appear to have most nearly approximated the facts as they eventuate. This Prize will be awarded as shortly after January 1, 1930, as is possible."

Contestants, therefore, were eligible to both Prizes. There were 438 essays submitted, all under assumed names. The decision was rendered by the Judges without knowledge of the identity of the contestants, and the names of the prize winners, with their awards, were announced on the 18th of June, 1925, at the annual convention of the National Electric Light Association, as follows:

FIRST PRIZE
$5,000

DAVID COWAN: *In 1925, with the Investment Department of Sun Life Assurance Company of Canada, Montreal, Canada. At present with McDougall & Cowans, Montreal, Canada.*

SECOND PRIZE
$1,000

ROBERT M. DAVIS: *In 1925, Statistical Editor of "Electrical World," New York, N. Y. At present, Statistical Editor, McGraw-Hill Publishing Co., New York, N. Y.*

THIRD PRIZE
$500

JOHN DOCKENDORF: *Was, in 1925, and still is with The Milwaukee Electric Railway & Light Company, Milwaukee, Wis.*

TEN PRIZES
$250 EACH

REUBEN B. SLEIGHT: *In 1925, Engineer Minnesota Tax Commission, University of Minnesota, Minneapolis, Minnesota. Since, deceased.*

ARTHUR R. STUBBS and CHARLES H. CHURCHILL, JR.: *In 1925, with Adirondack Power & Light Company, Schenectady, N. Y. At present Mr. Stubbs is Secretary-Treasurer of the Boyd Martin Boat Company, Delphi, Ind., and Mr. Churchill is Vice-President and General Manager, Cortland County Traction Company, Cortland, N. Y.*

CHAS. E. NEIL and CHASE DONALDSON: *Mr. Neil was, in 1925, and still is connected with the Publicity Department of The North American Company, New York, N. Y. Mr. Donaldson in 1925 was connected with Curtis, Fosdick and Belknap, New York, N. Y., and is now with Founders General Corp., New York, N. Y.*

M. L. SINDEBAND and P. SPORN: *In 1925 with American Gas and Electric Company, New York, N. Y. Mr. Sindeband is at present Vice-President, American Brown Boveri Company, New York, N. Y., and Mr. Sporn is Electrical Engineer, American Gas and Electric Company, New York, N. Y.*

A. K. BAYLOR: *In 1925, with General Electric Company, New York, N. Y. Since, deceased.*

C. P. DUNN: *In 1925, Designing Engineer of the Portland Electric Power Company, Portland, Oregon. At present, Chief Engineer, Alcoa Power Company, Ltd., Arvida, Quebec, Canada.*

C. T. CHENERY: *Was, in 1925, and still is a Consulting Electrical Engineer, New York, N. Y.*

THEODORE DWIGHT and REGINALD TRAUTSCHOLD: *Mr. Dwight was, in 1925, connected with Murray and Flood, Engineers, New York, N. Y. He has since retired and resides in New York, N. Y. Mr. Trautschold was, in 1925, with the Society for Electrical Development, New York, N. Y. He has since retired and resides in Pompton Lakes, N. J.*

DAVID EVANS, JR.: *In 1925, with Rutter & Co., New York, N. Y. At present, with the Lehman Corporation, Research Department in Charge of Public Utilities, New York, N. Y.*

MARION J. VERDERY, JR., and HENRY ALLEN MOE: *In 1925, Mr. Verdery was connected with Bonbright & Company, Incorporated, New York, N. Y. At present, he is a member of the firm of Quaw and Foley, New York, N. Y. Mr. Moe was, in 1925, connected with the Guggenheim Foundation, New York, N. Y., of which he is now the Executive Secretary.*

TEN PRIZES
$100 EACH

F. E. PIERCE and RICHARD T. DANA: *In 1925, with Construction Service Company, New York, N. Y. Mr. Pierce is at present a Consulting Engineer, New York, N. Y. Mr. Dana is since deceased.*

MERRILL E. SKINNER: *In 1925, Commercial Manager, Duquesne Light Company, Pittsburgh, Pa. At present, Vice-President and Commercial Manager, New York Power and Light Corporation, Albany, N. Y.*

PAUL A. RYAN: *In 1925, a Student, Graduate School of Business Administration, Harvard University, Cambridge, Mass. At present, Chief Statistician, American Gas Association, New York, N. Y.*

PEARSON WINSLOW: *In 1925, was with Bonbright & Company, Incorporated, New York, N. Y., of which he is now Vice-President.*

LOUIS R. DAVIS: *In 1925, Secretary of Business Research Corporation, Chicago, Illinois. At present, Engineer Cost Accountant, Commonwealth Edison Company, Chicago, Ill.*

CHESTER M. CLARK: *In 1925, with Merrill, Oldham & Co., Boston, Mass. At present, Assistant Vice-President in charge of Department of Analysis and Research, Stone & Webster and Blodgett, New York, N. Y.*

EDGAR A. VANDEUSEN: *In 1925, Hydraulic and Structural Engineer, Central Hudson Gas and Electric Co., Poughkeepsie, New York. At present, Headquarters Engineer, Midland Management, Incorporated, New York, N. Y.*

T. H. DILLON: *In 1925, Professor of Public Utility Management, Graduate School of Business Administration, Harvard University, Cambridge, Mass. At present, Assistant to President of the United Fruit Company, Boston, Mass.*

THEODORE H. BROWN: *In 1925, Assistant Professor of Foreign Trade, Columbia University, New York, N. Y. At present, Associate Professor of Business Statistics, Graduate School of Business Administration, Harvard University, Cambridge, Mass.*

FRANK K. SIMMONS: *Was, in 1925, and still is connected with the Blackstone Valley Gas & Electric Company, Woonsocket, R. I.*

In reviewing the essays in 1930, the Judges considered carefully the requirements as outlined in the original announcements and were confronted with many of the same difficulties which they faced in originally judging the papers in 1925. Needless to say, there were many papers possessing real merit which, nevertheless, failed to cover all the subjects which should have been included in an article of this scope. Certain papers, for example, which were technically excellent from an engineering standpoint, were strikingly weak in their discussion of the financial side of the industry. Certain papers, which manifested a remarkable grasp of the merchandising and public rela-

tions problems of the industry and presented valuable ideas in that connection, touched upon the engineering aspects only briefly.

In arriving at their decision, it was naturally impossible for the Judges to decide solely upon the basis of statistical accuracy, but it was also necessary for them to give consideration to the judgments expressed on more general topics.

After careful review of all of the essays submitted, the Board of Judges have unanimously granted The American Superpower Corporation award of $10,000 for the essay entitled, "The Development of the Electric Light and Power Industry of the United States during the period 1920-1930," by Reuben B. Sleight.

The Board of Judges takes this occasion to express its sincere regret that the author of this essay has died since the prize was offered. His essay, in the judgment of the Board, is worthy of an enthusiastic tribute. The Judges consider that it treats, in an adequate fashion, practically all phases of the development of the industry, that no important errors of judgment are displayed, and that the author ventured a considerable number of statistical forecasts that now exhibit remarkably small deviations from the actual data. Other essays contained a greater number of specific forecasts, and some of these forecasts were more accurate than those of Mr. Sleight. Still others contained isolated strokes of brilliant prophecy. However, Mr. Sleight excelled in general treatment, and the Judges have had no difficulty in reaching the unanimous conclusion that the prize be awarded for his essay.

For the benefit of the very considerable number of those interested in the industry who have requested copies of the winning essay, it is reproduced in this volume.

In tabulating the various quantitative prophecies of the five leading essays, certain interesting facts came to light. In the first place, four of the five essays were low in their estimates of energy generated during the year 1929. All were low in their estimates of capital invested, the average error in this case

being the largest among all of the major estimates. In estimating the gross revenue two of the five essays placed their figures higher than the actual figures and three lower. In analyzing the division of kilowatt-hours sold as between power customers on the one hand and domestic and commercial customers on the other, all of the five essays predicted that a larger proportion would be used by power customers during the year 1929 than was actually the case. One of the essays predicted a decrease of 9% in the cost of electricity to the domestic consumers, while the actual decrease was 17%. Another of the essays mentioned the growth in the use of the promotional type of rate in large cities, but, on the whole, this important subject was neglected.

On page 13 are given a number of the estimates made by these five leading essays as compared with the actual figures. Immediately following these comparisons appears an extended tabulation of statistical facts covering all phases of the electric power and light industry as of January 1, 1930. Accompanying this are some additional data, the effect of all of which is to bring up to date the figures presented in the "Data Book of Electric Light and Power Facts," which was presented for use in conjunction with the Bonbright Prize Competition in 1925. The items do not, in all cases, correspond with those published in the original data book for the reason that revisions were made later by the compilers of those statistics.

In reviewing the essays in 1925, the Judges were impressed by the almost universal optimism expressed in estimates of the growth of the industry between 1925-1930. It now appears that actual results have, generally speaking, exceeded the forecast made five years ago. During the period under review, the kilowatt-hour output, installed capacity, capital invested, number of customers and gross revenue have all continued a rate of growth not dissimilar in form to a compound interest curve. The question naturally arises as to whether this rate of growth will continue in the future. In order to throw light upon this most important question, the Judges have attempted to obtain

a cross-section of the opinion of the electric light and power industry itself.

The Directors of The American Superpower Corporation have obtained from the companies with which they are individually associated certain significant figures from operating subsidiaries. These data show certain facts of actual performance during the past five years, together with budgeted estimates for the next three years, divided into such headings as will be useful in making an analysis of the probable future trend of operations.

The companies or groups which have supplied this information are:

American Electric Power Company
American Gas and Electric Company
American Power & Light Company
The Commonwealth & Southern Corporation
Electric Power & Light Corporation
National Power & Light Corporation
Niagara Hudson Power Corporation
Public Service Corporation of New Jersey
The United Gas Improvement Company

The figures which were presented by these companies were for the operating companies only and were so restricted to indicate as closely as possible the true growth of the electric light and power business as such, without such extraneous factors as wholesale power to other utilities.

The figures presented, are, of course, totals for this entire group which approximate, in kilowatt-hours sold, 30% of the entire electric light and power industry in the United States, based upon statistics for 1929.

On making the final award in this contest the Board wishes to express its thanks to the many persons who have assisted in gathering and preparing data, and in particular to the staffs of the National Electric Light Association and the Electrical

World, whose assistance has contributed materially in making the contest possible.

By Order of The Board of Directors

ALFRED L. LOOMIS, *Chairman*

PREDICTIONS OF LEADING ESSAYS COMPARED WITH THE FACTS

THERE are presented below certain estimates as taken from the five leading essays and a few comments on some of the other predictions made in those essays. In tabulating these estimates, it was necessary in some cases to make adjustments where the predictions were made on different bases. The estimated figures have been set down simply in order of size and not in the order of the ranking of the essays.

ENERGY GENERATED IN K.W.H.

Year 1929—91,421,459,000

Estimates	*% Error*
81,020,086,000	− 11.4
85,188,000,000	− 6.8
87,550,000,000	− 4.2
90,000,000,000	− 1.5
92,000,000,000	+ 0.6

GENERATOR RATING IN K.W.

Dec. 31, 1929—30,021,000

Estimates	*% Error*
29,000,000	− 3.4
31,280,000	+ 4.3
31,649,400	+ 5.5
32,451,000	+ 8.2

GROSS REVENUE
Year 1929—$2,106,000,000

Estimates	*% Error*
$1,939,380,000	− 8.0
2,000,000,000	− 5.0
2,100,000,000	− 0.3
2,120,000,000	+ 0.7
2,150,000,000	+ 2.2

CAPITAL INVESTED
Dec. 31, 1929—$11,100,000,000

Estimates	*% Error*
$9,450,000,000	− 15.0
9,700,000,000	− 12.6
9,800,000,000	− 11.3
9,860,000,000	− 11.2
10,200,000,000	− 8.1

CUSTOMERS
Dec. 31, 1929—24,257,159

Estimates	*% Error*
20,092,000	− 17.2
21,270,000	− 12.5
22,500,000	− 7.2
22,800,000	− 6.1
23,230,000	− 4.0

Largest Steam Plant:

One essay predicted that the largest steam plant in operation December 31, 1929, would have a rating of 750,000 K.V.A. This is compared with an actual of 620,000 K.W. On the other hand, one essay predicted that the largest station in operation would have a rating of only 180,000 K.W.

Largest Steam Unit, Single Shaft:

The predictions on this subject varied from 60,000 K.V.A. to 100,000 K.W. as compared to the actual of 160,000 K.V.A.

Output of Hydro Stations:

Two essays estimated this, but in both cases were approximately 25% low.

Transmission Voltage:

Four of these five essays predicted that the highest voltage in use today would be 220,000, which predictions turned out to be correct. The other essay made no prediction.

Coal Consumption:

One essay predicted that by December 31, 1929, the maximum station economy would be one pound of coal per kilowatt-hour. This prediction corresponds with the present facts. One essay predicted that the average use for the year 1929 would be 1.55 pounds of coal per K.W.H. while another predicted 1.9 pounds. These predictions compare with an actual average use of 1.67 pounds.

Mercury Boiler:

One essay stated that the use of the mercury boiler would extend rapidly, another that it would have proved its right to occupy a high place as a means of obtaining efficiencies, and only one essay stated that it had not generally been adopted. This latter prediction corresponds more nearly with present conditions as at the end of the period there was only one unit in operation.

Powdered Fuel:

All five of these essays were unanimous in predicting extensive growth in the use of powdered fuel, which predictions were justified, as, in 1929,30% of all fuel generated energy was generated through the use of powdered coal.

Pressures:

One paper stated that maximum pressures in use would be 1,500 lbs. per sq. in., while three papers gave this figure at 1,200 lbs. and one estimated a limit of 1,000 lbs. The highest pressure in use as of December 31, 1929, was 1,400 lbs. per sq. in.

Farm Electrification:

On this subject there seemed to be a divergence of opinion. One essay said that there would be a striking increase in farm electrification, and another that by 1930 it would constitute one of the best loads. A third predicted that by 1930 14% of the farms would be electrified, while another put this figure at 8%. One essay, however, indicated that there would be no great development of farm electrification. These predictions compare with estimates that from 8.8% to 9.5% of farms are now electrified.

Municipal Ownership:

The five essays which went into this subject all agreed that the trend would continue to be against municipal ownership and that the percentage of the total output generated by municipal plants would not increase. As to the number of municipal plants, however, two definitely stated that the number would increase, while one predicted that there would be fewer plants in 1930.

Cost of Electricity:

Three of the essays definitely predicted that the cost of electricity would continue to decrease while one of the essays specifically estimated that the rates in effect to the domestic consumer in December 31, 1929, would be 9% lower than those of 1920. This latter estimate was very conservative, as the decrease since that time has been approximately 17%.

Domestic Refrigeration:

Four of the essays predicted a decided increase in domestic refrigeration, one essay saying that the growth of this business will have been one of the outstanding accomplishments of the decade. At the end of the decade there were approximately 1,850,000 electric refrigerators in use.

Holding Companies:

Three of the essays predicted tremendous growth of the percentage of the industry controlled through holding companies, one stating that the extensive rearrangement of interconnection of properties would have been well nigh impossible without holding companies, and another stated that by 1930 95% of generating capacity would be controlled by holding companies.

Rate Form:

This important question was mentioned in only one of the five essays, which stated that promotional rates would be in effect in some of the larger cities.

STATISTICS
of the INDUSTRY

STATISTICS OF THE ELECTRIC POWER AND LIGHT INDUSTRY IN 1930

In the following tabulation are presented data which show a fairly comprehensive statistical picture of the electric power and light industry during the year 1929, or as of January 1, 1930

Energy Generated in U. S.

By all sources (U.S.G.S.)		
Water Power	(35.6%)	34,628,994,000
Fuels	(64.4%)	62,723,391,000
Total		97,352,385,000
By Central Stations only (E.W.)		
Water Power	(36.4%)	32,390,395,000
Fuels	(63.6%)	59,031,060,000
Total		91,421,455,000

Kilowatt Hours Consumed

By Domestic Customers	10,100,000,000
By Commercial Customers	15,900,000,000
By Power Customers	41,421,455,000
By Electric Railways	6,800,000,000
By Municipal Lighting	2,000,000,000
Total Sold	76,221,455,000
Line Losses	16,800,000,000
Total Consumed	93,021,555,000
Net Imported	1,600,000,000
Total Generated in U. S.	91,421,455,000

Installed Capacity (*)

Steam in K.V.A.	25,300,000
Steam in K.W.	22,085,000
Steam in H.P.	29,500,000
Internal Combustion in K.V.A.	428,000
Internal Combustion in K.W.	381,000
Internal Combustion in H.P.	510,000
Total Fuel in K.V.A.	25,728,000
Total Fuel in K.W.	22,466,000
Total Fuel in H.P.	30,010,000
Water Power in K.V.A.	8,650,000

**Power factor (National) about 87%.*

INSTALLED CAPACITY (CONTINUED)

Water Power in K.W.	7,555,000
Water Power in H.P.	10,190,000
Total in K.V.A.	34,378,000
Total in K.W.	30,021,000
Total in H.P.	40,200,000

TRANSMISSION, CIRCUIT MILES	225,000
CAPITAL INVESTED	$11,100,000,000

EARNINGS

Gross operating	$2,106,000,000
Net operating before taxes	$1,171,110,000
Operating Ratio before taxes	44.3%
FARMS ELECTRIFIED	550,000 to 600,000
Percentage of total	8.8% to 9.5%

CUSTOMERS

Domestic	19,721,486
Commercial	3,456,434
Industrial	1,079,239
Total	24,257,159
POPULATION OF U. S. JAN., 1930*	121,951,856
PEOPLE IN WIRED HOMES	85,000,000
Percentage of Total Population	70%

PRIME MOVERS IN INDUSTRY DRIVEN BY CENTRAL STATION ENERGY H.P.	22,545,000
Percentage of Total	53%

MUNICIPAL OPERATION (1927)

Gross Income	122,437,000
No. of Plants	2,198
Output in K.W.H.	3,379,538,000
Percentage of Total Output (1927)	4.5%

Estimated, Jan. 1930, by United States Census Bureau

CUSTOMER OWNERSHIP

Total shares sold 1920-1929, inclusive	20,494,268
Total shares sold to date (1930)	21,000,307
Value of shares sold in 1929	$145,000,000

SECURITIES

Value sold in 1929	$1,460,458,000
Percentage for refunding	about 18%
Average yield at issue during 1929	
Bonds	5.31%
Debentures and Notes	5.64%
Preferred Stock	6.28%

PERMITS BY FEDERAL POWER COMMISSION

Total applications filed to date	1,002
Total acted upon to date	835
Total under Permit or License	416
Horse Power	10,100,000
Total filed in 1929	92
Total acted upon in 1929	50
Total granted Permits or Licenses 1929	18

ENGINEERING STATISTICS

Largest Steam Plant	
Now in operation	620,000 K.W.
Now in process	1,000,000 K.W.
Largest Single Shaft Steam Generating Unit	
Now in operation	160,000 K.V.A.
Now in process	176,000 K.V.A.
Largest Multiple Shaft Steam Generating Unit	
Now in operation	208,000 K.W.
Now in process	None larger

Largest Hydro Plant
Now in operation . . . . . 332,850 K.W.

Largest Hydro Unit
Now in operation . . . . . 52,000 K.W. / 70,000 H.P.

Maximum Hydro Head . . . . . 2,418 ft.

Maximum Steam Pressure . . . . . 1,400 lbs.

Maximum Steam Temperature
In service . . . . . 750°
In process . . . . . 1,000°

Maximum Station Economy
B.T.U. per net K.W.H. Annual 13,800
Monthly 12,500
Lbs. of coal per K.W.H. Annual . . . . . 1.00 lb.
Monthly . . . . . 0.86 lb.

Average Station Economy
B.T.U. per net K.W.H. 21,500
Lbs. of coal K.W.H. 1.67

Maximum System Economy
B.T.U. per net K.W.H. 16,800
Lbs. coal per net K.W.H. 1.3

Use of Powdered Coal
No. of Plants using 70
K.W. Thus installed as of 1/1/1930 4,000,000
Percentage of Total Fuel
Generated Energy made by powdered coal 30%

Use of Fuel Oil
No. of barrels, 1929 (Central Station only) 9,477,000

Mercury Turbine
No. in use 1
Maximum size . . . . . 10,000 K.W.

Lowest Unit Production cost per K.W.H . . . . 2.16 mills–K.W.H.

Largest Boiler
Capacity . . . . . 1,250,000 lbs. steam per hr.

Transmission Line Voltage
Highest in operation 220,000
Highest in process . . . . . None higher

Average size of Generating Plants . . . . . 8,000 K.W.

Longest bulk Transmission of Power . . . . . 250 mi.

Highest Generated E.M.F.
In service in U.S. . . . . . 22,000 v.
In process in U. S. . . . . . None higher
Foreign . . . . . 36,000 v.
Low temperature carbonization extent

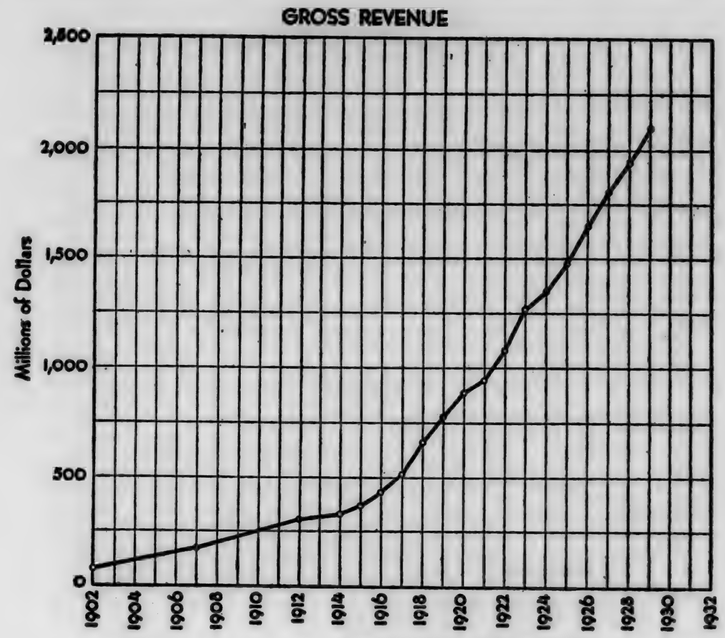
COMMERCIAL STATISTICS

Rates
Residential
Percent decrease since 1920 . . . . . 17%
Present average per K.W.H. 6.18c
Average bill per Customer (Annual) $31.02
Small Light and Power Average per K.W.H. 4.37c
Large Light and Power Average per K.W.H. 1.40c

Electric Refrigerators, Household
Now in operation 1,850,000
Percent "Saturation" 9.4%

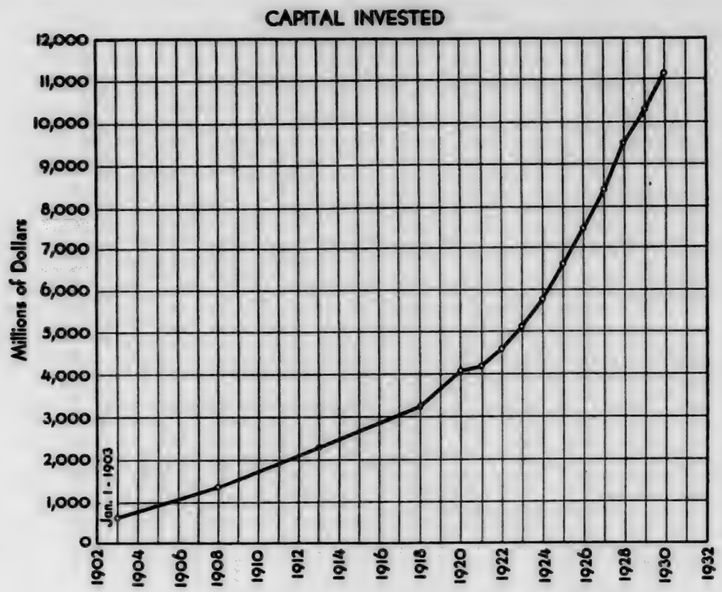
Numbers of Domestic Appliances
in Common Use—types 22

CHARTS *of the*
PAST HISTORY *of the* INDUSTRY



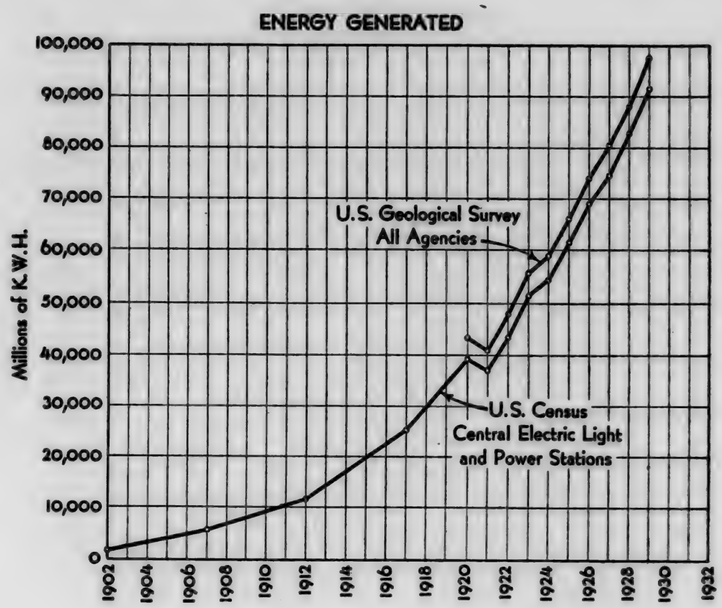
1902	$85,700,000	(U. S. Census)
1907	175,600,000	(U. S. Census)
1912	302,115,000	(U. S. Census)
1914	336,980,000*	E. W.
1915	360,000,000*	E. W.
1916	436,000,000*	E. W.
1917	521,000,000*	E. W.
1918	664,850,000*	E. W.
1919	773,650,000*	E. W.
1920	882,750,000*	E. W.
1921	944,400,000*	E. W.
1922	1,084,000,000*	E. W.
1923	1,269,550,000*	E. W.
1924	1,354,570,000*	E. W.
1925	1,480,500,000*	E. W.
1926	1,652,300,000*	E. W.
1927	1,802,655,000	(U. S. Census)
1928	1,941,955,000	E. W.
1929	2,106,000,000	E. W.

*Includes income from merchandising and other miscellaneous income.



Jan. 1, 1903	$627,000,000
Jan. 1, 1908	1,341,000,000
Jan. 1, 1913	2,289,000,000
Jan. 1, 1918	3,245,185,000
Jan. 1, 1920	4,100,000,000
Jan. 1, 1921	4,200,000,000
Jan. 1, 1922	4,600,000,000
Jan. 1, 1923	5,100,000,000
Jan. 1, 1924	5,800,000,000
Jan. 1, 1925	6,600,000,000
Jan. 1, 1926	7,500,000,000
Jan. 1, 1927	8,400,000,000
Jan. 1, 1928	9,500,000,000
Jan. 1, 1929	10,300,000,000
Jan. 1, 1930	11,100,000,000

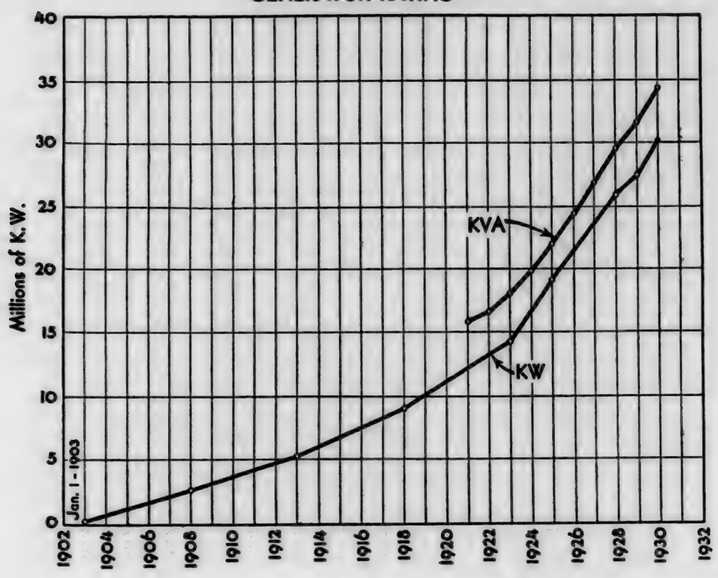
—E. W.



U. S. CENSUS of Central Electric Light & Power Stations		U. S. GEOLOGICAL SURVEY Including Electric Railways, Govt. Reclamation, etc.	
1902	2,507,000,000 KWH	1920	43,555,000,000 KWH
1907	5,862,000,000 KWH	1921	40,976,000,000 KWH
1912	11,532,000,000 KWH	1922	47,659,000,000 KWH
1917	25,438,000,000 KWH	1923	55,674,000,000 KWH
1920	39,519,000,000* KWH	1924	58,996,000,000 KWH
1921	36,971,000,000* KWH	1925	65,870,000,000 KWH
1922	43,560,000,000 KWH	1926	73,791,000,000 KWH
1923	51,133,000,000* KWH	1927	80,205,000,000 KWH
1924	54,413,000,000* KWH	1928	87,850,000,000 KWH
1925	61,159,000,000* KWH	1929	97,352,000,000 KWH
1926	69,158,000,000* KWH		
1927	74,686,000,000 KWH		
1928	82,927,000,000* KWH		
1929	91,421,000,000 KWH		

*—E. W. (est.)

GENERATOR RATING

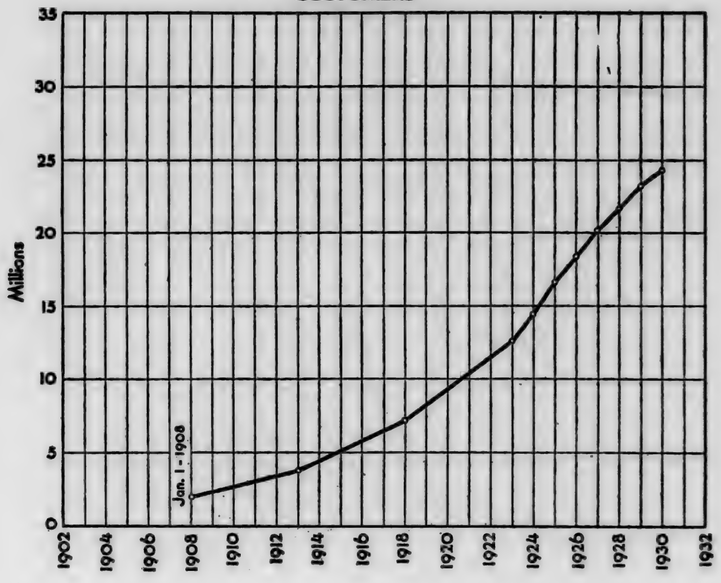


Jan. 1, 1903	1,212,235 KW	(U. S. Census)
Jan. 1, 1908	2,709,225 KW	(U. S. Census)
Jan. 1, 1913	5,165,439 KW	(U. S. Census)
Jan. 1, 1918	8,994,407 KW	(U. S. Census)
Jan. 1, 1923	14,313,438 KW	(U. S. Census)
Jan. 1, 1925	19,150,000 KW	E. W. (est.)
Jan. 1, 1928	25,811,305 KW	(U. S. Census)
Jan. 1, 1929	27,689,305 KW	E. W. (est.)
Jan. 1, 1930	30,021,000 KW	E. W. (est.)

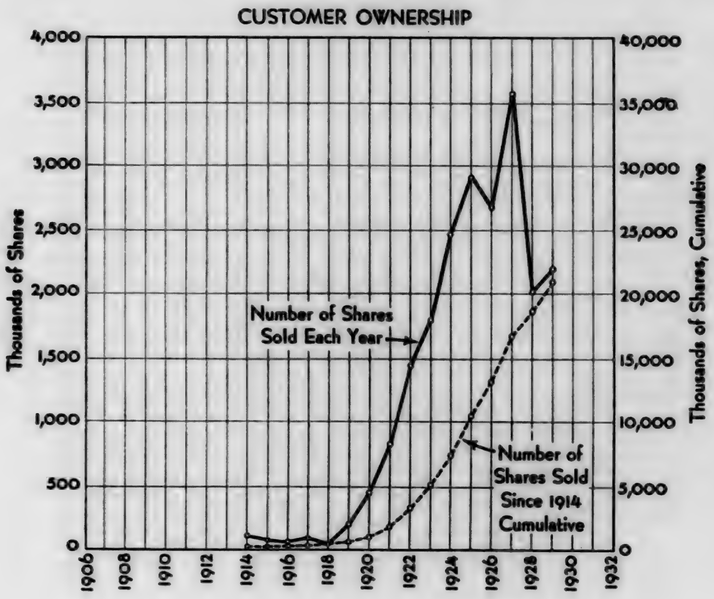
As Estimated by E. W.

Dec. 31, 1920	15,860,000 KVA	E. W. (est.)
Dec. 31, 1921	16,660,000 KVA	E. W. (est.)
Dec. 31, 1922	17,960,000 KVA	E. W. (est.)
Dec. 31, 1923	19,900,000 KVA	E. W. (est.)
Dec. 31, 1924	22,000,000 KVA	E. W. (est.)
Dec. 31, 1925	24,344,000 KVA	E. W. (est.)
Dec. 31, 1926	26,813,000 KVA	E. W. (est.)
Dec. 31, 1927	29,629,000 KVA	E. W. (est.)
Dec. 31, 1928	31,796,000 KVA	E. W. (est.)
Dec. 31, 1929	34,378,000 KVA	E. W. (est.)

CUSTOMERS



Jan. 1, 1908	1,946,000	(U. S. Census)
Jan. 1, 1913	3,837,000	(U. S. Census)
Jan. 1, 1918	7,178,703	(U. S. Census)
Jan. 1, 1923	12,709,868	(U. S. Census)
Jan. 1, 1924	14,627,158	E. W. (est.)
Jan. 1, 1925	16,786,509	E. W. (est.)
Jan. 1, 1926	18,472,146	E. W. (est.)
Jan. 1, 1927	20,178,531	E. W. (est.)
Jan. 1, 1928	21,790,238	(U. S. Census)
Jan. 1, 1929	23,219,513	E. W. (est.)
Jan. 1, 1930	24,257,159	E. W. (est.)



			Cumulative
1914	92,310 shares (N. E. L. A.)		92,310
1915	57,130 shares (N. E. L. A.)		149,440
1916	38,183 shares (N. E. L. A.)		187,623
1917	82,007 shares (N. E. L. A.)		269,630
1918	42,388 shares (N. E. L. A.)		312,018
1919	194,021 shares (N. E. L. A.)		506,039
1920	454,139 shares (N. E. L. A.)		960,178
1921	830,222 shares (N. E. L. A.)		1,790,400
1922	1,450,707 shares (N. E. L. A.)		3,241,107
1923	1,806,300 shares (N. E. L. A.)		5,047,407
1924	2,478,165 shares (N. E. L. A.)		7,525,572
1925	2,926,271 shares (N. E. L. A.)		10,451,843
1926	2,686,187 shares (N. E. L. A.)		13,138,030
1927	3,581,206 shares (N. E. L. A.)		16,718,236
1928	2,081,071 shares (N. E. L. A.)		18,800,307
1929	2,200,000 shares E. W.		21,000,307

COMPOSITE FIVE YEAR RECORD
and THREE YEAR PREDICTION

COMPOSITE FIVE YEAR RECORD AND THREE YEAR PREDICTION OF SELECTED COMPANIES

As INDICATED in previous pages, the Directors of The American Superpower Corporation collected from companies with which they were personally connected a record of certain significant statistics for the years 1925-1929 inclusive and an estimate for the years 1930-1932.

The companies who furnished this information are:

American Electric Power Company
American Gas and Electric Company
American Power & Light Company
The Commonwealth & Southern Corporation
Electric Power & Light Corporation
National Power & Light Corporation
Niagara Hudson Power Corporation
Public Service Corporation of New Jersey
The United Gas Improvement Company

The statistics are presented both in tabular and chart form in the following pages. There is also presented a table of derived statistics which will also be of interest. In furnishing this information the companies were requested to conform to the following specifications:

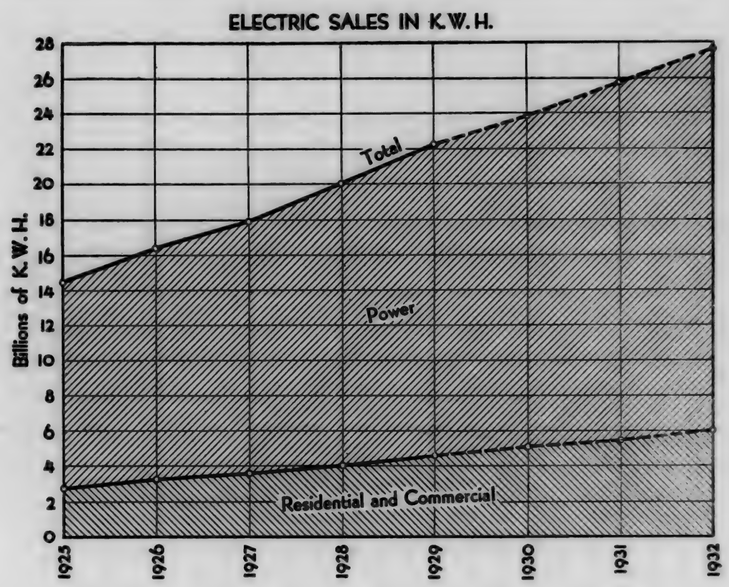
(a) Report for each operating company separately by years for the years 1925 to 1932 inclusive, actual for the expired years and estimated for the future.

(b) Report information for electric operations only.

(c) Eliminate all data pertaining to sales of electricity to other public utilities (including street railway companies) and use of electricity by street railway departments. For example, there should be eliminated from K.W. Hrs. sales,

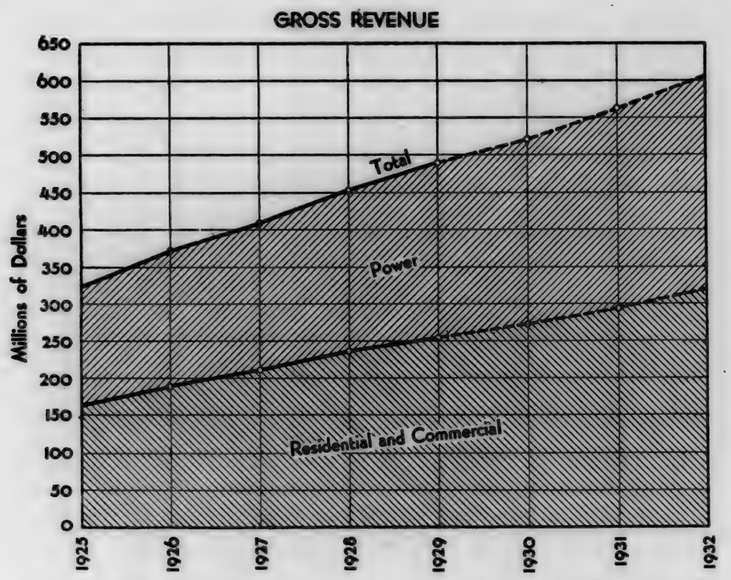
gross earnings and maximum demand, the results of sales to other public utilities and of use of power by railway departments, and a deduction should be made from operating expenses, in arriving at net income, equal to the amount of the operating costs of the power so sold or used.

(d) The results of any properties acquired as entireties during the expired period (1925 to 1929 inclusive) should be included for complete years prior to the time of acquisition back to January 1, 1925, in cases where the annual gross earnings at the time of acquisition amounted to $250,000 or more but in cases of properties acquired having smaller annual gross earnings no such adjustment should be made. Neither should anything be included on account of the probable purchase of properties in future years.



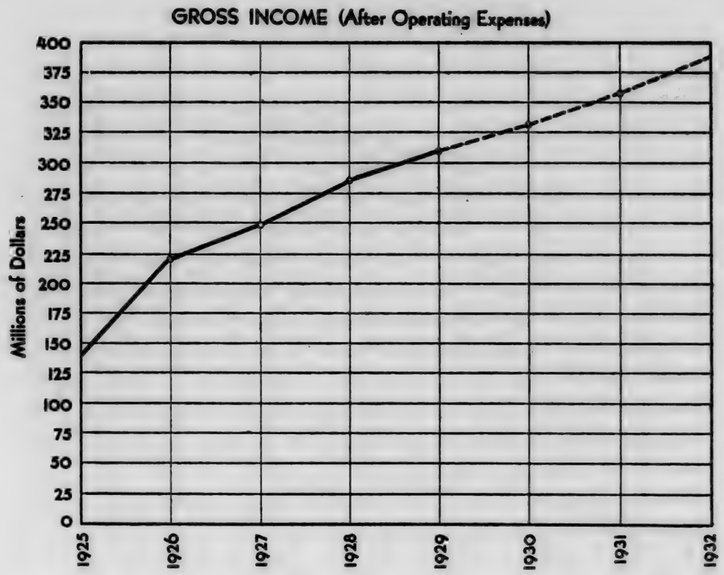
American Electric Power Company—American Gas and Electric Company—American Power & Light Company—The Commonwealth & Southern Corporation—Electric Power & Light Corporation—National Power & Light Corporation—Niagara Hudson Power Corporation—Public Service Corporation of New Jersey—United Gas Improvement Company

Year	*Residential and Commercial*	*Per Cent Increase Over Previous Year*	*Power*	*Per Cent Increase Over Previous Year*	*Total*	*Per Cent Increase Over Previous Year*
1925 Actual	2,764,370,248	.....	11,771,564,861	.....	14,535,935,109	.....
1926 Actual	3,224,726,625	16.6	13,263,626,605	12.7	16,488,353,230	13.5
1927 Actual	3,606,476,839	11.8	14,327,087,061	8.0	17,933,563,900	8.8
1928 Actual	4,064,933,087	12.7	15,996,271,050	11.6	20,061,204,137	11.8
1929 Actual	4,546,271,811	11.8	17,647,314,842	10.3	22,193,586,653	10.6
1930 Estimated	5,014,749,022	10.3	18,817,486,818	6.6	23,832,235,840	7.4
1931 Estimated	5,544,440,848	10.6	20,160,269,250	7.1	25,704,710,098	7.8
1932 Estimated	6,108,650,541	10.1	21,672,210,291	7.4	27,780,860,832	8.1



American Electric Power Company—American Gas and Electric Company—American Power & Light Company—The Commonwealth & Southern Corporation—Electric Power & Light Corporation—National Power & Light Corporation—Niagara Hudson Power Corporation—Public Service Corporation of New Jersey—United Gas Improvement Company

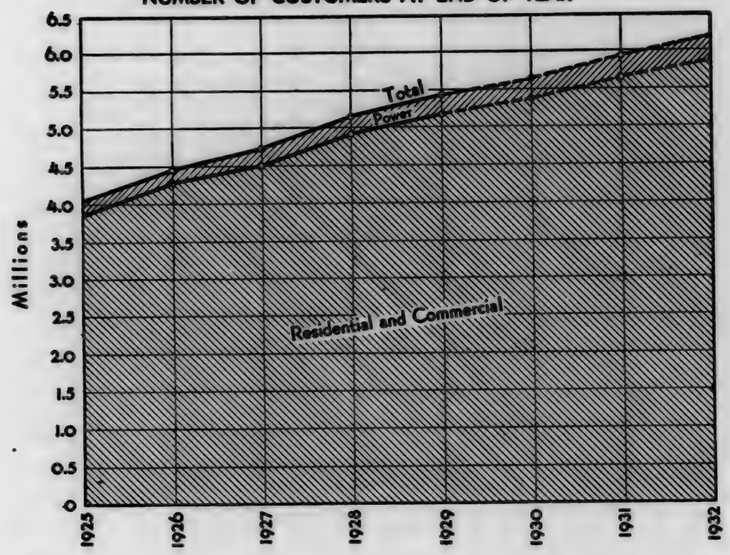
Year	*Residential and Commercial*	*Per Cent Increase Over Previous Year*	*Power*	*Per Cent Increase Over Previous Year*	*Total*	*Per Cent Increase Over Previous Year*
1925 Actual	$163,346,843	.....	$160,778,653	.....	$324,125,496	.....
1926 Actual	189,176,032	15.8	182,538,720	13.5	371,714,752	14.7
1927 Actual	211,503,485	11.7	197,886,218	8.3	409,389,703	10.2
1928 Actual	237,145,339	12.2	215,480,069	8.9	452,625,408	10.6
1929 Actual	255,987,178	7.8	235,556,915	9.2	491,544,093	8.5
1930 Estimated	273,033,108	6.7	248,904,194	5.7	521,937,302	6.2
1931 Estimated	295,249,410	8.1	266,762,026	7.1	562,011,436	7.7
1932 Estimated	319,604,550	8.1	286,759,620	7.5	606,364,170	7.8



American Electric Power Company—American Gas and Electric Company—American Power & Light Company—The Commonwealth & Southern Corporation—Electric Power & Light Corporation—National Power & Light Corporation—Niagara Hudson Power Corporation—Public Service Corporation of New Jersey—United Gas Improvement Company

Year		*Per Cent Increase Over Previous Year*
1925 Actual	$189,179,519	....
1926 Actual	221,287,312	17.0
1927 Actual	249,651,184	12.8
1928 Actual	285,303,179	14.2
1929 Actual	310,268,962	8.8
1930 Estimated	331,567,305	6.8
1931 Estimated	358,291,804	8.1
1932 Estimated	388,503,674	8.3

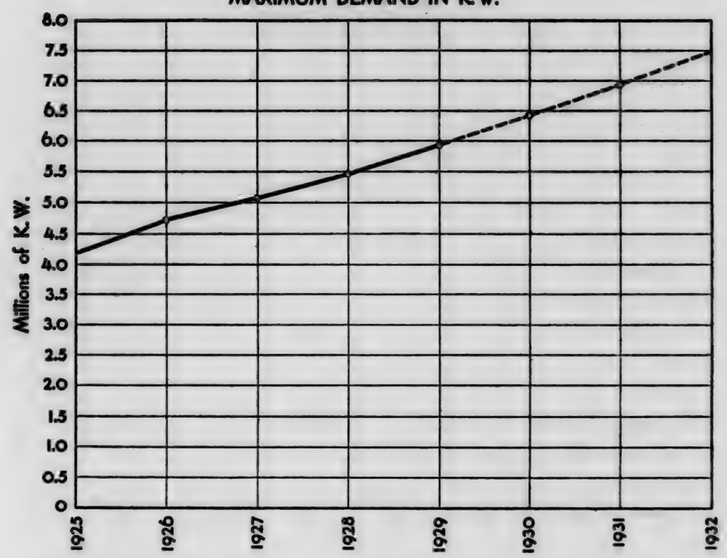
NUMBER OF CUSTOMERS AT END OF YEAR



American Electric Power Company—American Gas and Electric Company—American Power & Light Company—The Commonwealth & Southern Corporation—Electric Power & Light Corporation—National Power & Light Corporation—Niagara Hudson Power Corporation—Public Service Corporation of New Jersey—United Gas Improvement Company

Year	*Residential and Commercial*	*Per Cent Increase Over Previous Year*	*Power*	*Per Cent Increase Over Previous Year*	*Total*	*Per Cene Increast Over Previous Year*
1925 Actual	3,885,294	.....	159,039	.....	4,044,333	.....
1926 Actual	4,289,924	10.3	186,312	17.2	4,476,236	10.5
1927 Actual	4,504,839	5.0	211,803	13.7	4,716,642	5.3
1928 Actual	4,914,906	9.1	241,205	13.9	5,156,111	9.3
1929 Actual	5,176,612	5.2	252,862	4.8	5,429,474	5.3
1930 Estimated	5,365,111	3.7	278,728	10.2	5,643,839	3.9
1931 Estimated	5,643,416	5.1	300,174	7.7	5,943,590	5.3
1932 Estimated	5,864,805	3.9	320,429	6.7	6,185,234	4.1

MAXIMUM DEMAND IN K.W.



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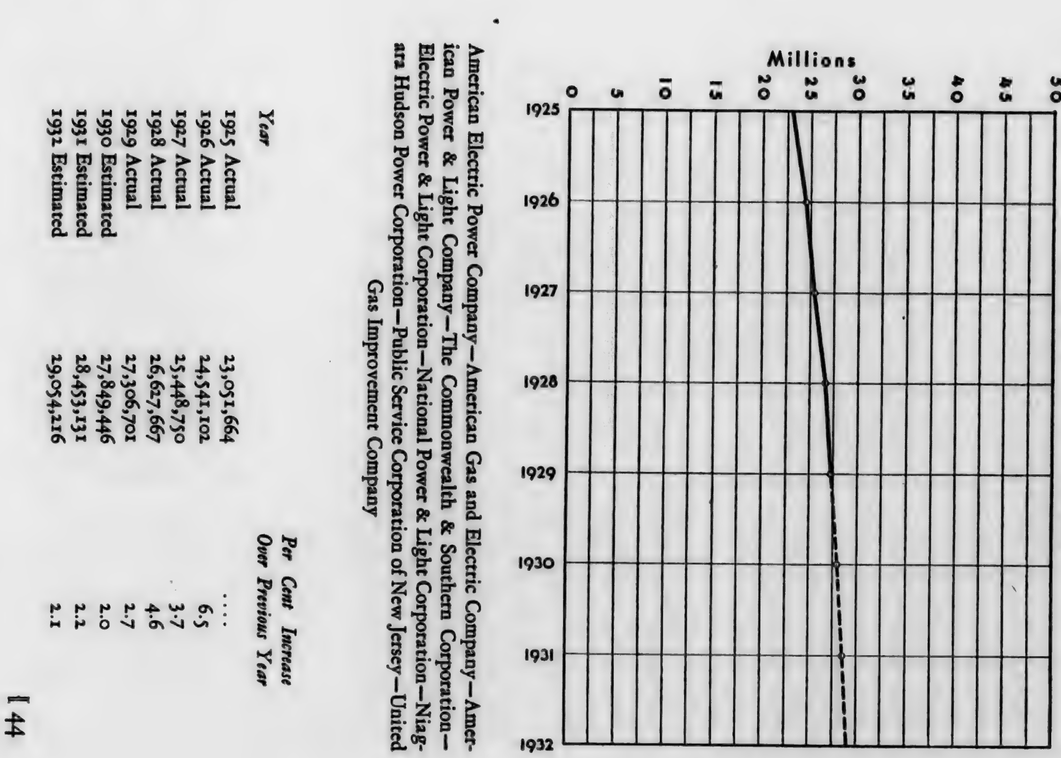
Year		*Per Cent Increase Over Previous Year*
1925 Actual	4,187,642	....
1926 Actual	4,723,530	12.7
1927 Actual	5,064,443	7.1
1928 Actual	5,469,216	8.0
1929 Actual	5,933,401	8.4
1930 Estimated	6,427,543	8.3
1931 Estimated	6,924,325	7.7
1932 Estimated	7,449,300	7.6



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Year		*Per Cent Increase Over Previous Year*
1925 Actual	23,051,664	....
1926 Actual	24,541,102	6.5
1927 Actual	25,448,750	3.7
1928 Actual	26,627,667	4.6
1929 Actual	27,306,701	2.7
1930 Estimated	27,849,446	2.0
1931 Estimated	28,453,131	2.2
1932 Estimated	29,054,216	2.1

DERIVED STATISTICS

American Electric Power Company—American Gas and Electric Company—American Power & Light Company—The Commonwealth & Southern Corporation—Electric Power & Light Corporation—National Power & Light Corporation—Niagara Hudson Power Corporation—Public Service Corporation of New Jersey—United Gas Improvement Company

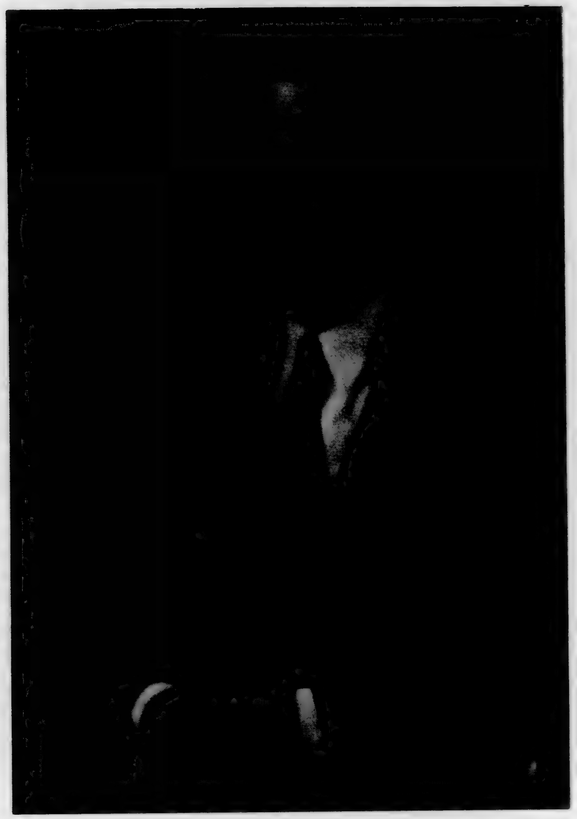
From the statistics presented on the preceding pages, the following table of derived statistics was calculated. Because they show some interesting trends in the electric light and power industry this data are here presented.

	1925 Actual	*1926 Actual*	*1927 Actual*	*1928 Actual*	*1929 Actual*	*1930 Estimated*	*1931 Estimated*	*1932 Estimated*
Average Revenue, Residential & Commercial—cents per K.W.H.	5.91	5.87	5.87	5.83	5.63	5.45	5.33	5.23
Average Revenue, Power—cents per K.W.H.	1.365	1.375	1.380	1.348	1.335	1.322	1.322	1.322
Average Revenue, Total—cents per K.W.H.	2.230	2.254	2.282	2.258	2.215	2.188	2.185	2.183
Ratio Residential and Commercial K.W.H. to Total K.W.H.—per cent	19.0	19.6	20.1	20.3	20.5	21.1	21.6	22.0
Ratio Residential and Commercial Gross to Total Gross—Per cent	50.4	50.9	51.7	52.4	52.1	52.3	52.5	52.7
K.W.H. per Residential and Commercial Customer	711.	752.	800.	828.	878.	934.	982.	1042.
Load Factor, per cent	39.6	39.8	40.4	41.9	42.7	42.4	42.4	42.6
Operating Ratio, per cent	41.7	40.5	39.0	38.3	36.9	36.5	36.3	36.0

THE WINNING ESSAY

Development of THE ELECTRIC LIGHT *and* POWER INDUSTRY *in the United States during the Period* 1920-1930

by REUBEN B. SLEIGHT



REUBEN B. SLEIGHT

A BIOGRAPHY

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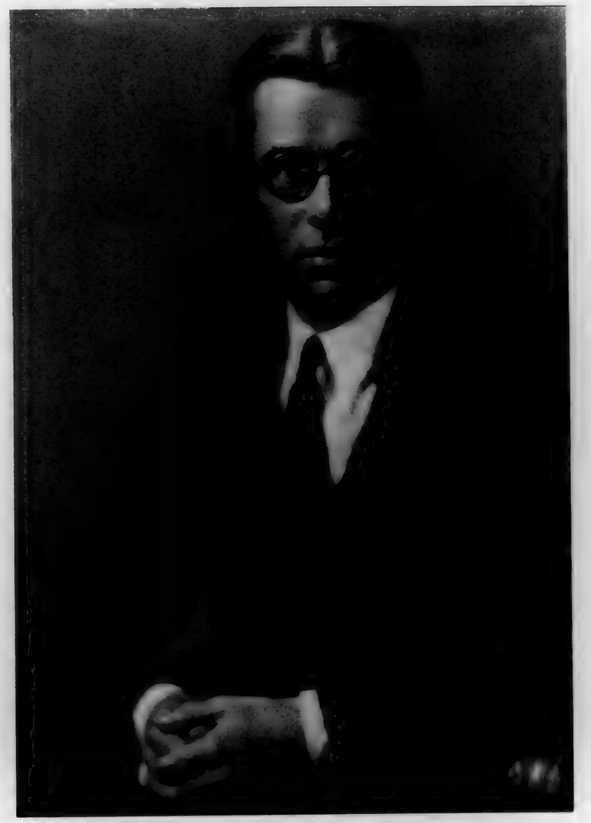
In June, 1911, Mr. Sleight left the University and took employment with the Racine Boat Manufacturing Company, at Muskegon, Michigan, as a Draftsman in the mechanical and structural design of lightships for the Federal Government. The opportunities of the West then attracted him to Denver, Colorado, where he entered the office of the Field, Fellows, and Hinderlider Engineering Company, in September, 1912.

In January, 1913, Mr. Sleight left this work and was employed immediately as Construction Foreman and Concrete Inspector on irrigation structures and well development for the Tucson Farms Company, near Tucson, Arizona. In June, 1913, Mr. Sleight was appointed Assistant Irrigation Engineer in the U. S. Department of Agriculture, which position he held until he entered the Army in 1917.

In September, 1914, on leave of absence from his Government position, Mr. Sleight re-entered the University of Michigan from which he was graduated as a Bachelor in Marine Engineering in the early summer of 1915. During his Senior year at the University, he was made an Assistant in the Department of Civil Engineering. On leaving the University and resuming his Government connection, in July, 1915, he was assigned to the work of establishing a research laboratory, at



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In September, 1914, on leave of absence from his Government position, Mr. Sleight re-entered the University of Michigan from which he was graduated as a Bachelor in Marine Engineering in the early summer of 1915. During his Senior year at the University, he was made an Assistant in the Department of Civil Engineering. On leaving the University and resuming his Government connection, in July, 1915, he was assigned to the work of establishing a research laboratory, at

Denver, for the purpose of studying evaporation from free water surfaces, soils, and river-bed materials.

Mr. Sleight's military career began in October, 1917, with his appointment as Production Engineer, Signal Corps, U. S. Army. In January, 1918, he was commissioned a Second Lieutenant in the Signal Reserve Corps. He was promoted to First Lieutenant, Air Service, U. S. Army, on September 25, 1918, and remained in the Air Service until July, 1919. He held the commission of Captain in the Air Service Officers' Reserve Corps until his death.

From 1919 to 1922 Mr. Sleight was associated as Appraisal Engineer with H. E. Riggs, at Ann Arbor, Michigan. In 1922 he severed his connection with the appraisal work to take the position of Engineer with the Minnesota Tax Commission, which position he held at the time of the Bonbright Prize Essay Competition in 1925.

In the fall of 1926 he resigned his position with the Minnesota Tax Commission to accept an appointment on the Engineering Staff of the United States Department of Commerce as an aide to the then Secretary, Herbert Hoover. As an assistant to Mr. Hoover he was detailed to work out special waterways problems. At the time of his death on November 14, 1927, he was in Vermont, having left Washington in an airplane to gather advance information in the areas then flooded. The injuries from which he died were suffered in the landing of the plane at Montpelier, Vermont.

Mr. Sleight was the author of a number of papers published in various engineering and scientific periodicals, was a member of the University of Michigan Chapter of Sigma Xi and was an Associate Member of the American Society of Civil Engineers.

Mr. Sleight was married on October 30, 1913, to Doris M. Cutter, of Muskegon, Michigan. He is survived by Mrs. Sleight and by a daughter, Ann.

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Development of the

Electric Light *and* Power Industry

in the United States during the Period of 1920-1930

BY

REUBEN B. SLEIGHT

WHAT UNIT of measurement shall be applied to the 1920-30 electric light and power development? Kilowatt hours, miles of line, dollars, number of employees, homes lighted, is any one of them alone suitable? Or can we get a proper conception from a consideration of individual happiness, standard of living, national well being and America's security? Perhaps a combination of the tangible and intangible will be best. The decade presents a series of records for all of those things that can be reduced to statistics,—plants built, use of power, financial operations, the entire extension of the electric utility. Percentages obtained from our population increase of 14 millions must be multiplied by from 10 to 15 to equal the changes in the power and light industry.

The vast number of persons enjoying its benefits indicates the far reaching influence of electricity upon our lives. Some 75 millions live in electrically equipped homes; 7 or 8 millions engage in occupations dependent upon central stations for source of power; perhaps 4 million are owners of stocks and bonds of electric light and power companies. These figures are several hundred percent above those of 1920.

Electricity, a servant doing the work of tens of millions of men, extracting our raw materials, operating our factories, facil-

itating our transportation and communication, making our highways more safe, our homes more comfortable and our country more prosperous and secure, can be the subject for volumes. Its development has had its acts of heroism, its romances and its sacrifices. These will continue. But the vision, the imagination and the every day toil of the engineers, the financiers, the administrators, together with efficient organizations and a growing understanding by the public have brought the electric power and light industry to its high position of today and furnished us with power at a lower cost than ever before. The 1920-30 accomplishments of these individuals and organizations are the ones that are to be reviewed here. The romances must be left to the poet and novelist.

The discussion of the decade's development has been divided into sections. The order of their presentation is not meant to emphasize the importance of any group of activities. Each is essential to the success of the others.

ENGINEERING

A catalog only of electric light and power engineering accomplishments of the past decade or any other of the last five would fill many pages. But few things can be mentioned. They will be discussed under five headings.

THE STEAM CENTRAL STATION

Increased efficiency in utilization of the potential energy of fuel is the outstanding feature in steam station development. In 1920 very few plants could generate, under regular operating conditions, a kilowatt hour of energy with less than 2 pounds of the ordinary grade of steam coal. By 1925 there were new stations that had an average operating figure of less than 1.5 pounds per kilowatt hour. Now, in the latest plants, the production of a kilowatt hour of electrical energy with less than a pound and a quarter of the average grade of coal is common.

Table I presents statistics of fuel consumption of the country as a whole. In terms of quantity of fuel the improved effi-

TABLE I

The consumption of coal, oil and natural gas in the production of electrical energy in the United States. All central stations, electric railway plants, and certain other plants that contribute to the public supply are included. The following average heat values were used in computing: Coal, 11,000 B.t.u. per lb.; oil, 18,700 B.t.u. per lb.; natural gas, 880 B.t.u. per cu. ft.
Data for columns 2, 4, 6 and 9, for 1920-24 from U. S. G. S. reports.

THE ENTIRE CONTINENTAL UNITED STATES

Year	Coal consumed		Oil consumed		Gas consumed		Total B.t.u. in fuel consumed	K.w.h. total production by fuel	B.t.u. consumed per kilowatt hour produced
	Tons	B.t.u.	Barrels	B.t.u.	M. cubic feet	B.t.u.			
1	2 Millions	3 Trillions	4 Millions	5 Trillions	6 Millions	7 Trillions	8 Trillions	9 Billions	10 Thousands
1920.....	37.1	815	13.1	82	24.7	22	919	27.2	33.8
1921.....	31.6	695	12.0	75	23.7	21	791	26.0	30.4
1922.....	34.2	752	13.2	82	27.2	24	858	30.4	28.2
1923.....	38.9	855	14.7	92	31.4	28	975	36.3	26.9
1924.....	37.4	823	16.6	103	48.4	42	968	38.7	25.0
1929.....	44.0	968	17.0	106	51.0	45	1,119	66.0	17.0

Heat efficiency improved from 10.1% in 1920 to 13.7% in 1924, and to 20% in 1929.
Coal equivalent per kilowatt hour produced: 1920, 3.07 lbs.; 1924, 2.27 lbs.; and 1929, 1.55 lbs.

ciency from 1920 to 1925 was sufficient to save the equivalent of 15,000,000 tons of coal in the year 1924. The 1929 output has been secured with the equivalent of 50,000,000 tons less of coal than would have been necessary under 1920 conditions, or a saving greater than the total amount of coal consumed during 1929, by plants generating electricity for public use.

Among the factors contributing to the improved efficiency are: more thorough combustion of coal and the conservation of heat by improved furnaces, larger boiler and turbine units, steam and air preheating, by bleeding and increased steam pressures.

In 1920 the 20,000 KW machine was large; there were but few of them. By 1925 several 50,000 KW units were being built and installed. The 100,000 KW steam driven electric generating machine is now in successful use. Three hundred pound pressures were high in 1920. A few large plants of 1924 and 1925 design used 550 pounds and one was put into use with a 1,200 pound boiler and 1,000 pounds at the turbine. At present in new designs there is a general trend toward the highest pressures of 1925.

The use of powdered coal as steam making fuel has extended. It is particularly good in the standby plant as banking of fires is eliminated and a minimum of attendance is required.

While practically all of the increased efficiency has been obtained on the heat side of the generating plant (the greatest opportunity for improvement existed there and still does) much has been done in generator design and in central station control.

It may be that the overall size of the plant has about reached its limit. It has increased from 100,000 KVA in 1920, to 300,000 KVA in 1925 and 750,000 KVA now. It appears that there are only three or four places in the country where this large size can be called advantageous or justified.

WATER POWER ENGINEERING

Notable items of hydro central station development include the manufacture and successful operation of the 75,000 horsepower turbine in a single unit, the development of various de-

vices in connection with the draft tube and tail race to increase head, and the building of remotely controlled or automatic power plants.

Efficiency in the turbine has increased but little. In that remaining margin there was not much upon which to work. The vertical reaction machine has been selected for most of the low and medium head plants, with the impulse wheel generally installed for the high head of developments of the Mountain and Pacific States. However, for a few high head plants the reaction turbine has been designed and operated satisfactorily. The propeller type runner is a development of the decade that gives high efficiencies and good operation. Adoption of higher specific speeds of runners has resulted in a reduction of size and cost of generating units.

Methods of hydro plant testing have improved, particularly water measurement. The National Hydraulic Laboratory has taken an important part in hydraulic research. Studies by individuals, by companies and by the Government have added much to our available data on water resources and development costs.

The quantities of earth and rock moved, and concrete placed in the past ten years have been enormous. However, to fairly describe the civil engineering accomplishments each project would have to be handled as the special problem that it is.

TRANSMISSION, SUBSTATIONS AND DISTRIBUTION

Higher voltages, longer lines, duplicate heavy duty circuits, better control and slightly lower losses mark the transmission developments. Maximum voltage in 1920 was 150,000, 1923 saw the first higher voltage in use, 220,000. The maximum is still 220,000. Higher voltages can be controlled and their equipment built, but have not appeared to be economically justified as yet. With the scattered large sized steam plants in industrial districts 125 to 150 miles is about the maximum distance for transmitting large quantities of power over single lines. So in

few cases have voltages over 150,000 been thought justified in the eastern half of the country.

The high voltage line completely encircling large cities has been extended in use. Really an extension of the power house high tension bus, it probably, by having numerous substations, has done as much as any one thing to insure a continuity service in the city.

High tension underground has been delayed longer than desirable because of the lack of a satisfactory high voltage cable. In 1920 there was very little underground above 15,000 volts. One hundred ten thousand volt cable is now available but the cost has prohibited its use except where very large concentrated city loads are such that they can no longer be handled by the admittedly undesirable nearby plant. Automatic substations, while not new to the decade, have increased in popularity.

Distribution systems of hundreds of small cities and villages have been rebuilt with heavier conductor as large companies have acquired the properties either from the municipality or in consolidation of companies. Whole suburbs have been laid out for and supplied with underground electric service.

ILLUMINATION AND ELECTRICAL APPLIANCES

Illumination presents more contact points between the industry and the public than does any other use. A gradual change in the lamp itself, better direction and reflection of the light, our homes wired in a manner to make them more truly electrical, not only in lighting and decorative effects, but also for the use of appliances, are notable accomplishments. A really effective placing of the street light and the production of proper devices for highway lighting are new to the ten-year period.

The electrically operated refrigerating plant for the home has been made practical in the decade. Range regulation has been simplified. The electric laundry, the electric kitchen, the electrically heated bathroom, the electrically cooled bedroom, the electrically operated sewing room, electrically cleaned floors

are not, of course, developments of the period, but their improvement to ultimately make possible the 100% electric home has progressed far.

INDUSTRY

Scientific developments of the 1920-30 period in the electrification of industry that will have great effect upon central station production are in the electrochemical and electrometallurgical fields.

For several years, before 1920, electric furnaces were available for some special heating processes. Furnaces for steel foundry use, and some in malleable shops, were put into use in 1919 and 1920 with quite general success. Very little extension was needed up to 1925, but since many new installations with improvements have been made, bringing to the central station a load desirable as to both power factor and load factor.

In the field of electrochemistry, as apart from the operation of electric furnaces, zinc and aluminum production are among the leaders. Magnesium, electrically produced, in commercial quantities, is a development of the decade, and in the last five years has assumed importance. The production of fertilizer in concentrated form is just beginning and has a potential demand for large quantities of power as the process becomes more nearly perfected.

The electrical engineer has succeeded in producing a satisfactory high power factor motor in the small sizes. The electrification of excavating equipment, the replacement of steam by electric hoists in mines, the complete electrification of many coal mines, cutters, loaders and all haulage motor operated, has taken place rapidly.

Even though the industrial load is nearly 65% of the total central station load, except in this general way, it is not possible to describe here the engineer's part in the electrification that has taken place. It has been a process of motorization and application of electricity in nearly every branch of extractive, transformative and distributive industrial endeavor.

CENTRAL STATION CAPACITY AND LOAD

At the beginning of the 1920-30 decade there were in America central stations having a total capacity of 14,609,000 KVA. By 1925, additions and new plants made the figure 25,800,000. At the end of ten years the rated capacity of all generators of central electric light and power stations in the United States is 37,300,000 KVA. The 1920 generating capacity has been multiplied by over two and one-half. Or if based upon population there has been an increase from 0.138 KVA to 0.316 KVA for every man, woman and child in continental United States. From where has the demand that required such an enormously increased capacity come?

Two principal sources are responsible, industry as represented by manufactures and mines, and the classification, lighting, comprising residential, commerical and municipal. Although the greatest relative change has been in the lighting load, industry now as in 1920, has much the greater requirement. The third demand is transportation. Its change has been relatively small.

At our manufacturing plants and mines as reported by the 1919 census, there was installed power supplying equipment of over 36,000,000 horsepower capacity. (Manufactures 29,500,000, mines 6,700,000). Thirty percent was in motors operated by energy purchased from central stations. Now with 49,000,000 horsepower in manufacturing plants and mines slightly over 50% depends upon central stations for its power. This makes an increase in motor capacity of 13,800,000 horsepower. The energy consumed by these motors and by industrial heating and chemical processes not represented by the horsepower figures was 28,375,000,000 KWH more in 1929 than in 1920. Table II presents the statistics in some detail by sections of the country.

The lighting load has shown a very much higher proportional increase. The number of lighting customers was 7,271,000 Jan. 1, 1920. Now there are 22,220,000 and the average consumption of electrical energy per customer is nearly 50% higher

TABLE II—Central Station Capacity and Principal Items of Load in the United States by Sections—1920-30.

Section	Central Stations Capacity	Domestic and Commercial Lighting Customers	Consumption of energy generated by Central Stations				Power at Lines and in Manufacturing Plants	
			Lighting	Power in Industry*	Electric Rys. and Electrified Steam Roads	Total	Total	Electric Motors operated by power purchased from Cent. Stations
	Jan. 1, 1920	Jan. 1, 1920	1920				1919 Census	
	Thousand KVA	Thousands	Millions of Kilowatt hours				Thousand H. P.	
New England	1,446	686	411	1,300	310	2,021	3,860	1,263
Middle Atlantic	3,535	1,282	1,150	4,450	1,760	7,360	10,657	2,847
South Atlantic	1,565	330	345	2,720	470	3,535	3,644	1,153
East North Central	3,570	1,855	926	4,266	1,600	6,786	8,885	2,893
West North Central	1,286	963	484	1,275	285	2,044	1,911	671
East South Central	547	354	160	645	235	1,040	1,853	428
West South Central	482	303	135	505	85	725	1,784	259
Mountain	645	358	230	1,210	183	1,623	1,402	583
Pacific	1,533	940	740	2,560	710	4,010	2,115	953
Total U. S.	14,609	7,271	4,581	18,925	5,638	29,144	36,211	10,930
	Jan. 1, 1930	Jan. 1, 1930	1929				Jan. 1, 1930	
New England	3,700	2,090	1,670	2,830	560	5,060	4,700	2,250
Middle Atlantic	8,100	5,500	6,880	10,066	2,500	19,440	13,000	5,800
South Atlantic	2,600	1,430	1,290	7,250	675	9,215	5,500	2,850
East North Central	10,500	5,500	4,610	12,300	2,770	19,690	13,500	7,600
West North Central	3,900	2,860	2,100	2,566	315	5,075	2,250	1,200
East South Central	1,600	880	750	1,866	360	2,970	2,550	1,050
West South Central	1,400	1,100	660	1,850	135	2,645	2,500	800
Mountain	2,080	660	580	2,400	225	3,205	1,750	1,050
Pacific	3,440	2,100	2,310	6,250	1,060	9,620	3,250	2,150
Total U. S.	37,300	22,220	20,960	47,360	8,600	76,920	49,000	24,750

*Includes the motor load represented by Motors at Mines and Manufacturing Plants and in addition the Chemical and Industrial Heating Loads.

than 10 years ago. Thus the total energy increase for this class has been from 4,581,000,000 in 1920 to 20,960,000,000 KWH in 1929. It alone used as much last year as the total production for all purposes in 1915.

In 1920 the central stations had around 5½ million residential customers. It was estimated that 25% of the homes were then adequately supplied with appliances. But by 1925 when an additional 5½ million residences had been connected to central stations, competent authority estimated that only 18% had a full equipment of the common appliances. Intensive educational campaigns were begun about the middle of the decade. Research work was placed under way to secure more data relative to the value of appliances to both the serving utility and the customer. Electric home demonstrations were staged. Service surveys were made by the power and light utilities. The results are mutually satisfying to the company and consumer. Now, with nearly 19 million homes with electric service, over 30% are well equipped with electric appliances in addition to lights.

The electric railway load is larger than in 1920, but the increase has been relatively slight. Some sections show practically no change. Others, in which are located large centers of population, have greater demands about in proportion to the population growth. In addition, and shown by table II with the electric railway consumption, a few of the large cities and their surrounding territory, now use some energy for steam railroad electrification.

Steam road electrification demands upon the central stations of electric light and power companies have almost entirely developed in the past decade. At the time of the first electrification, around 30 years ago, the railroads built their own power plants and continued the policy up to 1920 or thereabouts, when the early contracts were made by the railroads and central station companies for energy. Terminal electrification during the past few years has to some extent been following the plan of purchasing power. Although this was advocated years ago by

progressive power company executives, not until the railroad company officials were convinced that a power service equal to or better than their own could be furnished by the electric power industry, did the railroad corporations contract with the power companies for energy. It is now becoming widely recognized that the production of electrical energy is not the transportation companies' business, and that the plan of purchasing it from the central station companies is superior.

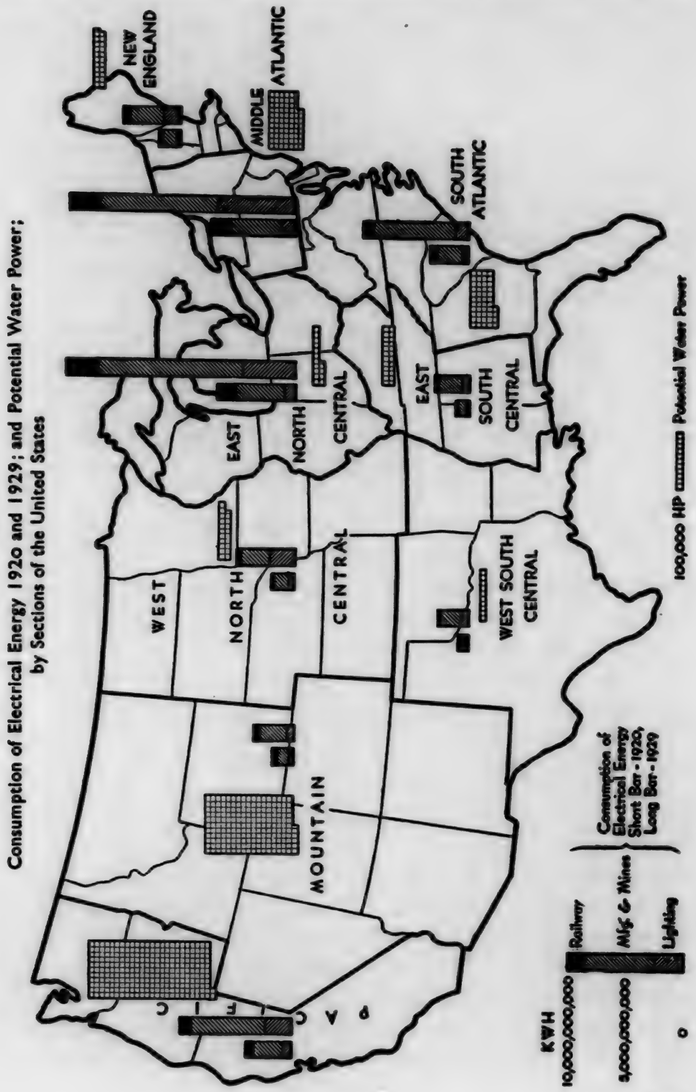
Summarizing, there has been used in 1929 a total of 76,920,000,000 KWH, as against 29,144,000,000 KWH in 1920. This means that the central electric light and power stations have had to generate 92 billion KWH. A slightly improved capacity factor has made this possible with a generator capacity that has not grown quite in proportion to the load. This factor is discussed in another section. A much better capacity factor may be expected as the load becomes more evenly balanced and interconnections are extended.

Figure I indicates graphically the relative changes that have taken place in central station load in the past decade. Figures II and III present curves of central station capacity and production. The production figure for 1929 is comparable to those of the U. S. Bureau of the Census for prior years. The 92 billion is production of central electric light and power stations only. There is not included energy generated by electric railway plants and such other power stations as are reported upon monthly by the U. S. Geological Survey.

In Figure II is the division of central stations as between fuel burning and water power plants. Less than 30% of the total KVA at the present time is capacity of hydro electric plants. And as to location, 82% of the fuel burning plant capacity and 52% of the hydro plant capacity is east of the Mississippi. This indicates the extent to which the electrification of industry has had to depend upon fuel. It must continue to use fuel to produce the major portion of the power required. The ratio of water power plant capacity to fuel plant capacity can increase but little, if any, and ultimately it must decrease a good deal.

FIGURE I.

Consumption of Electrical Energy 1920 and 1929; and Potential Water Power; by Sections of the United States



The figures of the U. S. Geological Survey's estimate of potential water power in the United States (announced 1924) are the basis of this statement. The potential developed and undeveloped water power in the United States available 50% of the time is 55,030,000 horsepower. We now have primary power capacity as follows, not including steam railroads:

Type:		
Central electric stations .	40,000,000	*Horsepower*
Electric railway plants . .	4,000,000	
Power plants of manufacturing establishments and mines (not including motors operated by central station energy) . .	24,250,000	
	68,250,000	*Total Hp.*

FIGURE II.

Capacity of Generators in Central Electric Light and Power Plants in the United States

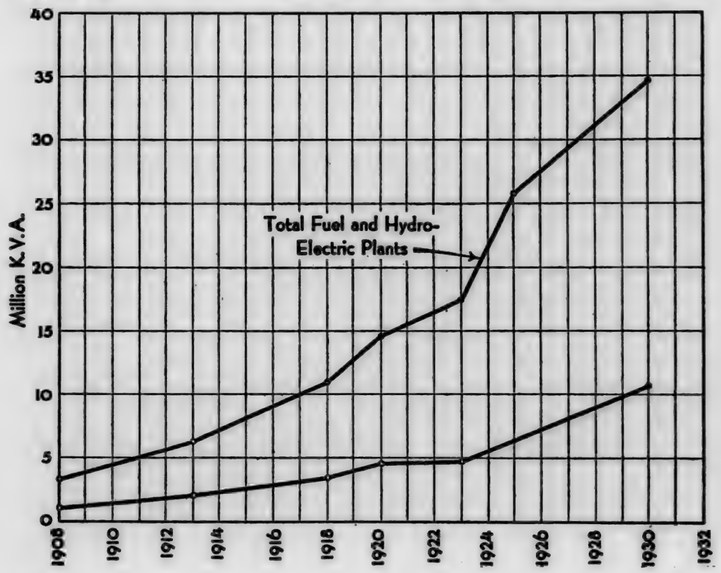
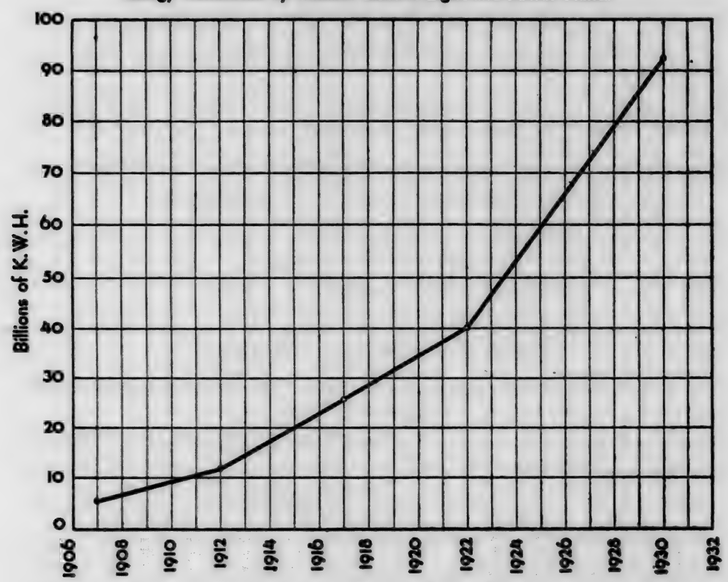


FIGURE III.

Energy Generated by Central Electric Light and Power Plants



Central stations of the electric light and power industry now have a capacity equal to nearly 75% of all the potential water power in the country. The distribution of the potential water power is:

Section:			
	New England	1,978,000	*Horsepower*
	Middle Atlantic	5,688,000	
	South Atlantic	4,464,000	
	East North Central	1,391,000	
	West North Central	1,844,000	
	East South Central	2,004,000	
	West South Central	888,000	
	Mountain	15,513,000	
	Pacific	21,260,000	
		55,030,000	*Total Hp.*

From this distribution and from table II, it is seen that while only 29% of the central station capacity is west of the Mississippi, 72% of the nation's water power is there. Further, just about 80% of industry, as represented by manufacturing and mines, is at present east of the Mississippi River. The nation's industrial center has moved from the Atlantic coast toward the Mississippi gradually over a period of scores of years. But for it to move to the location of our greatest water power resources, the Mountain and Pacific States, is almost inconceivable. Can Mountain States power be brought to middle west industry? Future developments only can answer the question.

THE COMMERCIAL ASPECT

Divide the decade into two five year periods, analyze the acquisition of new electric light and power business during each, both are found to approach the condition of a seller's market. This is more evident during the first half decade due to the readjustment and catching up processes after the war. But even though such was the case, it was accompanied by very little selection of new business. The load was taken as it came, or as fast as the utilities could build plants and extensions to care for it. It represented a growth natural under the conditions, but not as would be planned to get the maximum use of equipment.

The selective procedure cannot be followed by the electric light and power utility to the extent of accepting or refusing new business offered it; but means for balancing the load and improving both power factor and load factor do exist. The new business of 1925-29 has been of a slightly more desirable kind in general than that of 1920-24. In the past six years, more than ever before, commercial departments have been seeking loads for off peak periods, such as truck charging and certain heating and chemical processes; to get a wider use of household appliances; of electric signs; and to promote such other sales as

balance the load. The results of the efforts are noticeable, to a limited extent upon some load curves, just beginning in other cases. In another five years the ratios depending upon these factors will be materially improved.

Rates for some classes of service, business that has developed largely since 1920, were in the beginning figured upon a very indefinite basis. The electric range load is an example. Rule of thumb, without much rule at that, determined charges before the N.E.L.A. investigation of 1924-25. Other studies by this association have aided commercial departments in building rate structures and in the load selection problem.

It can be said that there are now fairly generally adopted basic rate structures for nearly all classes of service. Even as late as 1920 there were a great number of flat rate residential customers. Many utilities charged a fixed amount per kilowatt hour regardless of quantity, modified perhaps by a monthly minimum. More equitable schedules have been or are being worked out by nearly every progressive company, and for many municipally owned systems. Widely used today, and showing the greatest growth in the past ten years is the rate structure combining service, demand and energy charges. Methods of computing, applying and billing vary, but the basic principles are similar, and in the ten years this type of schedule has become standard practice.

Agriculture is said to be the greatest industry of the nation, the basic industry. The railroad man admits that, but his qualification is that transporation has made agriculture what it is. The statement is perhaps true. What about the relation of agriculture and the electric light and power industry? What can electricity do for farms? A problem is presented the solution of which falls not to the commercial department, as such, but one which is going to require management, engineering and legal thought as well. The reason for its discussion here is that commercial departments have in the past been most generally called upon to handle what has been done.

There are in the neighborhood of 6,000,000 farms in the United States. Around 15% have some kind of electric service, either their own direct current storage battery plants or central station connections. This electric service goes little further than lights for the buildings and a few household appliances. What is the motor capacity that might be advantageously used on these 6,000,000 farms? As yet we do not know. A good deal of study has been put upon the entire question in the past ten years. One notable experiment, that of a line built in a prosperous farming community, had as cooperating agencies the State Agricultural College, the Farm Bureau, the U. S. Department of Agriculture, the manufacturers of motors and appliances, and, of course, the farmers and power and light company. Several such attempts have been made at a start toward solution of the problem. Progress is recorded.

Unless the average farmer can use a much greater amount of energy than the average urban lighting customer, it is difficult to make the service profitable to either farmer or utility. It is believed that the situation is better than in 1920. The report of the "Committee on the Cost of Rendering Service" in Michigan in 1922, states relative to 47 power and light utilities "None of them reported profitable business from rural lines." In 1925, in one of the west north central states, company officials stated that they were about breaking even on farm business. This was in a prosperous farming community, one which came through the period of depression much better than the average. There is more rural business being handled each year. It is becoming an appreciable amount to many middle western utilities. But to put the use of electricity by the farmer on a basis at all comparable to the benefits that even the smallest manufacturer receives, much new farm equipment must be devised. For the average American farmer, central station service is very much of a luxury. He knows as the matter now stands, when he can have it at all, that it must be charged toward a more comfortable life for his family and not as a money making investment. He is sacrificing other things to provide that comfort. High invest-

ment per customer and a good deal of the large transformer and line losses are pretty apt to remain. The electric light idea must be supplanted by the electric power conception for economical farm use. The development of advantageous means so that the farmers' electrical energy consumption can increase with benefit to his operation is the only way that cost to him can be reduced, and the utility serving can make a reasonable profit. As that gradually takes place there is opened a wide field for the central station. Even two horsepower per farm would make a total equal to nearly one-third of the present central station capacity.

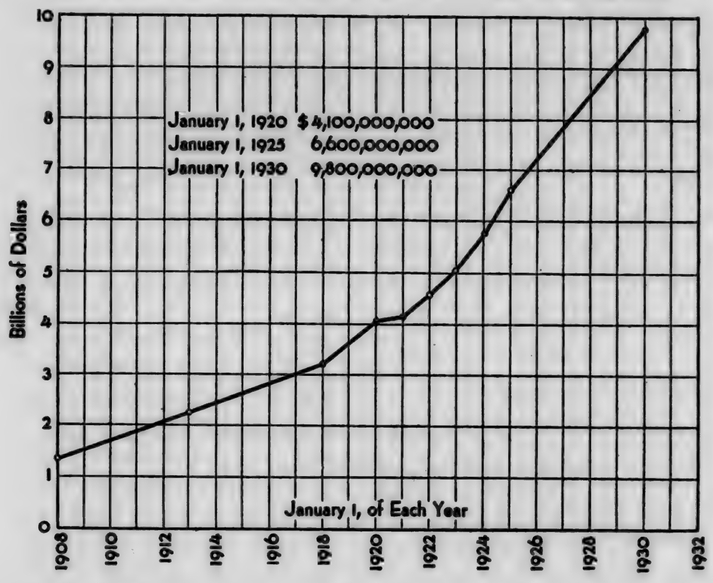
THE FINANCIAL SIDE OF THE POWER AND LIGHT INDUSTRY

In this age we are rather prone to use the dollar too much as the standard of comparison. But when the attempt is made to gauge the magnitude of our material things the monetary unit is the one by which most of them are best measured. It seems that the curve Figure IV, capital invested in the electric light and power industry, immediately makes the observer realize the vastness of a great undertaking. Its magnitude, the rate of growth, and the confidence that the American investor has had in it, all are portrayed. It cannot present a picture of the labor, the thought and study, and the sacrifices that have accompanied its growth.

A good deal of foreign capital went into our railroads and other industries. Electric light and power development has been almost entirely with American money, nearly 60% of it in the past ten years. America's confidence has been such that it has been possible to finance to the extent of adding 5 billion 7 hundred million in the decade. Financing to the amount of nearly 1¼ billion dollars in 1924 was a remarkable accomplishment. Securities were put on the market faster than ever before, but even as the monthly offerings became larger, the cost of the money went down.

FIGURE IV.

Capital Invested in the Electric Light and Power Industry in the United States



Three things seem to stand at the head of the list as being most important in electric light and power financing of the decade. They are not new to the period but their application has been widely extended. They are the open end mortgage, customer ownership of stock and the place of the holding company in the scheme of organization. But one of them applies strictly to financing. The other two have a bearing upon public relations, management and operation as well as financing. The open end mortgage is primarily a financing means.

The desirability of the open end mortgage as applied to power and light properties came to be recognized very widely at the time of rapid expansion and heavy refinancing in the first half of the decade. The issue, based upon a fixed percentage of capital expenditures, immediately becomes an index of property

value. Short term securities do not have to be issued at heavy discounts under normal conditions. Calling securities under unfavorable circumstances is largely eliminated. The serial bonds of the open end mortgage make unnecessary the expenses of a sinking fund. These bonds may all be offered as first mortgage, and as a result sell at a relatively higher price that would make a purely refunding issue necessary because of a closed first mortgage. It is not strange that the plan has, in ten years, gained such wide popularity.

Making the public a partner by sales of stock to customers was begun in the west, pushed most vigorously in the middle west and now it is hard to find a company that has not adopted it as one means of adding new capital.

From 1920 to 1925 the average holdings of all stock in power and light companies dropped from 50 shares per stockholder to about 30. In 1919 sales of stock to customers were less than 195,000 shares. In 1924 the figure had been multiplied by 10 and the average sales per year for 1925-29 have been 2,400,000.

The customer owns the power company serving him. This is not true as to proportion of investment or voting power. But the individual holders of small blocks of stock are the ones who are getting service and represent public opinion. Policies must be formulated to satisfy the customer. However, to satisfy him, not only must the property be maintained to give him the most efficient service and keep his investment intact, but it must be managed in such a manner as to pay him a dividend upon his investment. He therefore controls. He further demands that members of the regulating bodies, elected by him, or appointed by the official for whom his vote is cast, fairly and judiciously handle the matters affecting his company.

A good deal of the rearrangement and interconnection of properties that has taken place in the 1920-30 decade would have been well nigh impossible without the holding company. The strength for bringing together credit and a consolidation of financing power must come from some such organization. Through it there has existed the means of averaging a common

stock risk and securing common stock capital so that a safe investment is available to the public.

The financial structures of some of the operating corporations under holding company control have been quite severely criticised. It is said that the proper stock and bond ratio has not been maintained. It is true that those operating companies which closely adhere to a 50-50 division between stock and bonds, and in particular the ones that have but one class of stock, head the list as to financial rating.

Holding company service is not confined to financing. Engineering ability that could not be afforded by the independent company is available for application to that same property if under the direction of a holding company. Management that the independent system could never secure is provided by the supervising organization. On the whole dependable holding companies have been a real asset to the power and light industry through the last ten years and have probably done more than any other one agency to develop interconnection and superpower.

The great amount of money invested has been mentioned and a curve of investment increase presented. From where has the money come and what has been its cost? Attention is directed to Figure V. First is the amount from company sales to customers. During 1920-24 this averaged $123,000,000 per year, and 1925-29 $240,000,000. This made only a small part of the total. Investment houses handled an average of $750,000,000 per year during 1920-24 and $875,000,000 per year for the remainder of the decade. Refinancing, however, required $250,000,000 per year for the post war period 1920-24 and $235,000,000 per year for 1925-29. Refinancing of the first half decade had many millions of war period short term notes to take care of, and that of the second half has included the calling of issues of small companies under merger, the replacement of other securities with lower priced money, in addition to the regular maturities. Summarizing, the annual investment increment has been $500,000,000 per year for the first five years, and $640,000,000

per year for the remainder of the period under discussion.

About a quarter of the money involved in expansion and refinancing of the electric light and power industry in the past ten years has come from the company sales of stock, both common and preferred. Not many companies have offered common stock, except those having but one stock classification, however. The recognition by the investor of the stability and essential character of the industry applies not only to the individual buyer of securities but many organizations have taken large pieces. Insurance companies have invested millions; educational institutions are using power and light securities for endowment purposes; and now that savings banks are being given an opportunity to invest in them the demand is large and new money costs relatively much less than ten years ago.

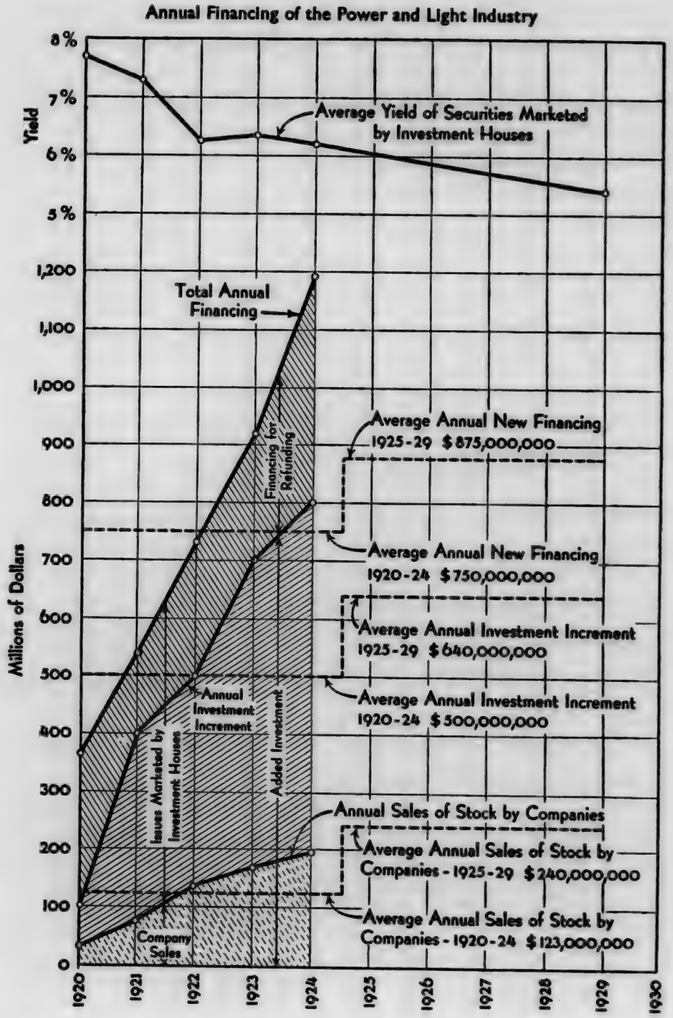
The curve at the top of the sheet, Figure V, gives the average yield of power and light securities marketed by investment houses for the past ten years. The figures for 1920-24 are the weighted average of all power and light securities handled by these institutions, based upon the amount of issue, the rate and the selling price. The figures are: 1920—7.7%; 1921—7.3%; 1922—6.24%; 1923—6.34% and 1924—6.23%. There has been a gradual decrease since January, 1925, so that the average yield for 1925-29 has been between 5½% and 5¾%.

Figure VI is presented. Gross revenue for 1929 was $2,150,000,000. In 1920 it was $882,750,000. The increase of $1,267,250,000 accompanied an added investment of $5,700,000,000. The ratio of added investment to increase in annual revenue of 4.5 is quite satisfactory when compared with a total investment and total revenue ratio of 4.9 for 1918, 4.65 for 1920 and 4.55 at the end of 1929. And this accompanies a decrease from 3.03c per KWH in 1920 to 2.79c in 1929 for all energy sold by power and light companies in the United States. It means a power bill of $185,000,000 less for 1929 than would have been required under the average rate of 1920, an amount sufficient to pay the interest on 3 billion dollars.

In this connection it is interesting to note that according to

FIGURE V.

Annual Financing of the Power and Light Industry

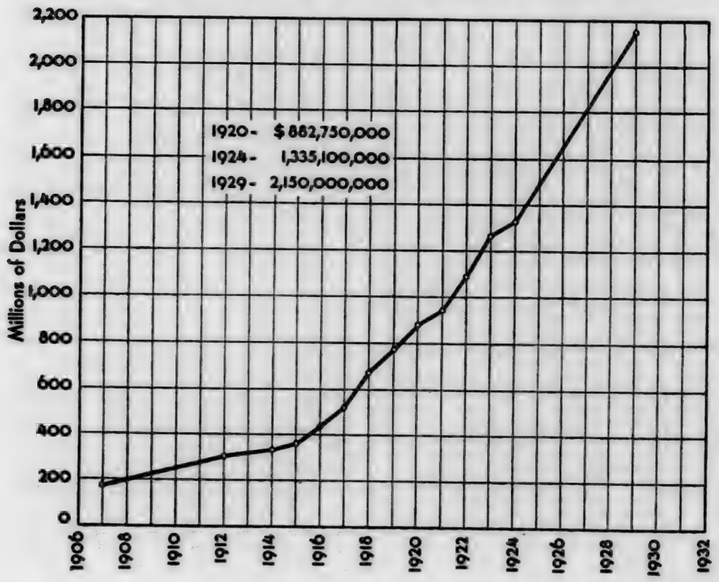


the U. S. Bureau of Labor index of the cost of living, retail electricity is the only commodity that is below and has continuously remained below the 1913 level since that date. And this condition has existed while all other commodity classifications have been from 30% to 185% above the 1913 base during the 1920-30 decade.

Operating ratios have shown little change over the period. Slightly less than 50% in 1920 for the entire country, a gradual increase to 52½% in 1924 was recorded. Since then the figure has at times gone several per cent below 50 but the ten year average is close to 50%. This compared with the added investment—increased gross revenue ratio, is one index of the stability and financial soundness of the industry. The net income ratio

FIGURE VI.

Gross Revenue—the Electric Light and Power Industry in the United States



has therefore remained fairly constant through 1920-29. With judicious commission regulation about the only changing influence upon this at any time can be a raising or lowering of the price of money.

The aspect of the power and light industry on the whole, is one of a vast beneficial agency, selling its product lower than that of other comparable services, well managed, soundly financed and presenting a conservative and stable offering to the investor.

PUBLIC OWNERSHIP, REGULATION AND PUBLIC RELATIONS

Public ownership of utilities, a live issue in many political campaigns during the past decade, has perhaps been discussed more than during any other ten years of our history. It found little support during the presidential campaign of 1924. California and Washington went on record with decisive rejection of public ownership bills, and Chicago voters defeated the proposal for municipally owned surface and elevated lines. On the other hand, Detroit early in the decade purchased her street railway system and has operated it for about eight years. The advocates of public ownership point to government operation in other countries, to our own municipality owned water works systems and to our municipal electric light and power utilities which are operating with varying degrees of efficiency and satisfaction. Private ownership supporters are those who are justified in their belief that the efficient organization such as that of the power and light companies can best serve them and the country with the electric necessity. This discussion will not be a brief for either municipal or private ownership—there is but one way that the electric light and power industry could have developed and can develop in the future to render the service that it must continue to furnish, and that is not public ownership.

The number of municipally owned electric light and power plants has increased slightly in the past ten years, but the pro-

duction is less than 5% of the nation's total. Many old municipal systems have been purchased by companies who now supply continuous and reliable service. The new plants that have been built by cities are, as a rule, good engineering jobs, well operated, and take care of the needs of the community with fair satisfaction.

However, the best of the municipal systems, other than distribution works, do not and can not fit in with any interconnection or superpower plant. The operation of municipal electric light and power systems in a manner to promote national conservation of fuel and waterpower resources cannot in any way be compared to the satisfactory operation of municipal water utilities. The water utility is confined to one comparatively small community. Electric light and power lines extend over state boundaries.

Our national government's few business ventures have not proven particularly successful. Many of the state attempts to enter business have been more disastrous. It does not seem likely that public ownership of the electric light and power industry will be experimented with in a big way. Our present plan of customer ownership of stocks and bonds, with continued fair regulation by Commissions, is going to remain intact.

The Interstate Commerce Act was passed in 1887. It has been amended at various times since. After 1906 the Interstate Commerce Commission had very wide regulatory powers. Perhaps there was too much regulation; however, unbiased students assert that governmental control of some roads was well deserved. That is not a matter for discussion here. The majority of the state bodies having more or less jurisdiction over steam railroads followed the Interstate Commerce Act of 1887.

The formation of agencies having regulatory power over the power and light industry has come about in the reverse order, first the state public utility commissions, and the national body, Federal Water Power Commission, not until 1920.

The Federal Water Power Commission exercises jurisdiction over a part of the power and light industry in that there are

comprehended by the Act supervision of development, capitalization, rate making and service to a certain degree, at all hydro electric sites on lands of the United States and on navigable and international boundary streams. Jurisdiction over water power for any purpose whatsoever is included, but much the greater part of the development has been and will be by the power and light industry. Eighty-five percent of all of the available water power of the nation is affected.

That a license of 50 years' duration, and that the provisions of the Act are considered reasonable is indicated in a material way by the results of ten years' operation. In the first five years, plants with a total capacity of 597,000 HP were completed or under construction. Licenses for construction and preliminary permits had been issued up to 8,460,000 HP. In the second five years additions to the country's central stations in plants completed and under construction exceed 2½ million horsepower.

The Water Power Act provides for state regulation either by the commission or by state agencies. The states have had the necessary regulating bodies and in most cases have exercised the regulating power over rates and service. There have been proposals in the last ten years tending toward some sort of national body with jurisdiction over the entire light and power industry. Need for federal regulation other than that of the Federal Water Power Commission, does not exist. State regulation is now superior to any other kind. And home rule, so called, has not given and can not give the public and the utility the uniform judicial treatment that the state commissions generally have given and will give.

In 1923 all but 11 states had bodies with unqualified jurisdiction over the privately owned power and light industry. Included were valuation for rate making, rates, service and in most cases, capitalization. Four of the remaining states had limited jurisdiction and 7 had no state regulation whatsoever. The total production of electrical energy of the seven amounted to less than 4% of that of the nation. The one with the largest production of the 7 has now extended the powers of the com-

mission which then existed to include the electric light and power industry.

Valuations and rates have been the most important of the state commissions' duties. Before the world war the problem of determining an index of value was not the complex one that it became in the first half of the 1920-30 decade. Cost of reproduction based upon costs over a period of five or ten years was quite generally accepted as a starting point. Price changes seemed to upset that. In 1920, we were much at sea as to a proper price basis to be used for appraisal purposes. Engineers submitted estimates founded upon several sets of prices. Recommendations were made pro and con. But all came back to the historic Smyth vs. Ames case.

Mr. Justice Hughes in the Minnesota Rate Cases stated:

> "The basis of calculation is the 'fair value of the property, used for the convenience of the public. (Smyth vs. Ames, 169 U. S. 546). Or, as it was put in San Diego Land & Town Co. vs. National City, 174 U. S. 757: 'What the company is entitled to demand, in order that it may have just compensation, is a fair return upon the reasonable value of the property at the time it is being used for the public.' * * * * The ascertainment of that value is not controlled by artificial rules. It is not a matter of formulas, but there must be a reasonable judgment, having its basis in a proper consideration of all relevant facts."
>
> (Simpson vs. Shepard, 230 U. S. 434)

How should that value be determined? And also in the Minnesota Rate Cases:

> "As the company may not be protected in its actual investment, if the value of its property be plainly less, so the making of a just return for the use of the property involves the recognition of its fair value if it be more than

> its cost. The property is held in private ownership, and it is that property, and not the original cost of it, of which the owner may not be deprived without due process of law."

Then coming to the first decision after the war:

> "It is a matter of common knowledge," said the Supreme Court in the Lincoln Gas Case (250 U. S. 246), "that, owing principally to the World War, the costs of labor and supplies of every kind have greatly advanced since the ordinance was adopted, and largely since this cause was heard in the court below."

On May 2, 1923, the Supreme Court stated in the Southwestern Bell Telephone Case (262 U. S. 276):

> "It is impossible to ascertain what will amount to a fair return upon properties devoted to public service, without giving consideration to the cost of labor, supplies, etc., at the time the investigation is made. An honest and intelligent forecast of probable future values, made upon a view of all the relevant circumstances, is essential. If the highly important element of present costs is wholly disregarded, such a forecast becomes impossible. Estimates for tomorrow can not ignore prices of today."

But Mr. Justice Brandeis, in the Georgia Railway and Power Case (262 U. S. 265) June 11, 1923, takes us back to the Minnesota Rate Cases and indirectly to Smyth vs. Ames:

> "The refusal of the Commission and of the lower court to hold that, for rate making purposes, the physical properties of a utility must be valued at the replacement cost less depreciation was clearly correct. As was said in Minnesota Rate Cases, the ascertainment of that value is not controlled by artificial rules. It is not a matter of formulas,

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These extracts from decisions of the highest court of the land are quoted to better present the problem before our public utility commissions at the beginning of the decade. Testimony before them has been conflicting as opinions will ever be. Readjustment of thought by the public, the commissions and the companies to properly measure changed conditions was difficult. On the whole one cannot be other than impressed by the fact that "reasonable judgment" has been exercised.

There were many appeals early in the decade. As business conditions gradually became more stable and a somewhat firmer price level established, these appeals have not been numerous. The tendency in fixing value now is to give considerable weight to current prices. It appears that there is hardly an alternative when such a large share, around 70%, of the investment in the power and light industry represents construction since the war time high price period began.

It has taken years to clear up confusion that resulted from a misapplication of the term depreciation. Primarily depreciation means loss of value. The word has been applied to the allowance for replacement or renewal as used in accounting, and to loss of service life as used in engineering practice. Neither of the two usages of the term necessarily implies loss of value.

The longevity theory is being rejected as a measure of value of public utility property. The property is a continuing thing. It was never built to remain new, but to give service and as long as it gives 100% service its value remains intact. In one of the best discussions of the subject, Mr. Justice Moody said in 1909 (Knoxville vs. Knoxville Water Co. 212 U. S.):

> "It (the company) is entitled to see that from earnings the value of the property is kept unimpaired * * * * *."

Even so, some of the so-called public utility experts have vigorously supported the idea that age and loss of value are almost directly proportional.

Fortunately our commissions and courts, in the past five years more than ever before, have held that only in the case of inadequacy of maintenance and replacements is there loss of value, and that such loss of value is measured by the expenditure in money that would be necessary to restore the property to a normal operating efficiency.

Our commissions and courts have had difficult problems in the consideration of valuations and rates. These have been handled with judicial fairness. The regulating bodies are to be commended for their assistance in making available to the public a beneficial service such as that of the electric light and power industry.

The American generally recognizes service when he gets it. The industry has emphasized service and its employees have given it. A spirit of good-will has grown up that, to bring in the comparison again, the railroads probably never have enjoyed. The customer has had a chance to become an owner in a non-speculative, stable industry that is giving him service, and his attitude toward another type of public ownership, toward the regulating body, and toward the company is one that will promote the further development of electric light and power in America.

INTERCONNECTION AND SUPERPOWER

Early in the decade, when the first 220,000 volt transmission line had proven successful in operation, predictions of transcontinental lines at this or higher voltages were common. As yet we haven't them. Perhaps they will not exist in the near future. The public's conception of superpower has included such an interconnection plan. It is true that we have the means at hand to bring Mountain States hydro electric energy to the upper Mississippi and Great Lakes industrial districts. Constant potential lines at 220,000 or 330,000 volts would do it.

But the losses coupled with the great investment necessary for these lines have made it cheaper to haul fuel to our steam plants. Whether or not this course is the best for America's future only developments of that future can tell. Immediate utilization of all available water power and conservation of fuel seems better, but as a business project under the conditions of the past decade and probably for some time yet long line transmission, above 250 to 300 miles, is not economically justified.

Superpower developments of the past ten years, have then not consisted of the building of huge mine mouth steam plants or out of the way water power stations with long transmission lines. Rather they have been the interconnection of independent systems, isolated plants, and the unification of districts or zones.

There has come about a closer co-operation between companies operating in adjoining territories, and many consolidations have been made. In 1924 alone, mergers took place in sufficient numbers to reduce the operating companies about 325. Compare this figure of one year with an average of about 90 per year from 1917 to 1922, as indicated by an analysis of figures of the U. S. Bureau of the Census. As the result of the co-operation and mergers, and within the districts which are becoming superpower zones many benefits are already evident. A better utilization of water power, particularly if on different water sheds, is being brought about; the load that could be carried on formerly separate systems has been increased by relatively diminishing peaks; operation is becoming possible with less reserve equipment; all of these tend toward a better capacity factor and conservation.

Communities are benefiting. The smaller ones that have been paying the penalty of high rates because of inefficient low load factor, isolated plants, are beginning to notice a change. Industry can become somewhat decentralized and population better distributed as interconnection is completed, or as superpower extends.

Superpower was no new thing to the power and light

industry when it began to receive wide public attention some eight or ten years ago. Engineers and company executives had for years been making plans to that end. Many of the economies that could be realized were known. But it is safe to say that except in few sections had the construction programs been such as to accomplish much until the present decade.

The studies involved by such investigations as the Superpower Survey of the Washington-Boston District, a co-operative investigation between our National Government and the utility companies of the region (incidentally the first introduction of superpower to the public); the Transmission Committee of the Empire State Gas and Electric Association; the Superpower Committee of the Pacific Northwest; Power Survey Committee of the Great Lakes Division, N. E. L. A.; Giant Power Survey of Pennsylvania; together with several comprehensive private investigations marked steps of utmost importance in a national power program. These took place in the first half of the decade. Up to 1925 but one study of the entire United States had been presented to the public. This, a personal contribution, dealt largely with the transmission problem.

Early in the second half of the decade the co-ordination of results of all district surveys up to that time and the formulation of a complete national plan was started. In this the National Electric Light Association has had the co-operation of the United States Government, State Governments, its members, and such vitally interested industries as the electric railways, steam roads and others. There is resulting a comprehensive power plan for America.

Most advantageous locations for large steam plants are pointed out. Order of development of water power is suggested. Standardization of voltages and frequencies is covered. On the whole, the study has as its object the formulation of a complete plan for maximum utilization of water power, conservation of fuel, economical use of electrical energy and a reliable and constant power and light service at a low cost. But these items are not all. This work of comprehensive planning and

co-ordination is justified in a prosperous nation like ours if for no other purpose than that of National Defense.

The plan must necessarily be a general one. It cannot give detailed recommendations for each company's procedure. However, it is satisfying to know that it is being followed. Construction programs are being made with the maximum utilization of existing facilities in mind. Many interconnecting lines have been built, and while small plants have been dismantled in great numbers and their loads assumed by the more efficient large station, decentralization of great power centers is taking place wherever possible.

An attempt has been made by Figure VII to indicate regions of interconnection. Some are now largely interconnected within the section, but only a few equipped as yet for more than emergency transfer of power between districts. Upon the character of the loads of adjoining sections depends the justification for large capacity lines between them. If a lighting load in one can be balanced by an industrial load of another, then the interchange of power will make less generating equipment necessary and improve the load factors.

California was the first state to become largely interconnected and it now has the highest capacity factor of any region, better than 50%. The water power district of the South Atlantic States was a close second. The New England and Middle Atlantic Sections are working out their part of the comprehensive plan. The industrial districts of the East North Central States have made good progress. A part of the West North Central Section is well tied together, but municipal ownership in some parts of that section has handicapped its progress. Ultimately we shall have all power companies within a region or zone either consolidated or working as one unit in the production and distribution of electrical energy. That will be accompanied by contact points between the zones, in some cases for interchange of rather large quantities of power, but as a rule for emergency service only.

Superpower has its start, it is here. Its results are becoming

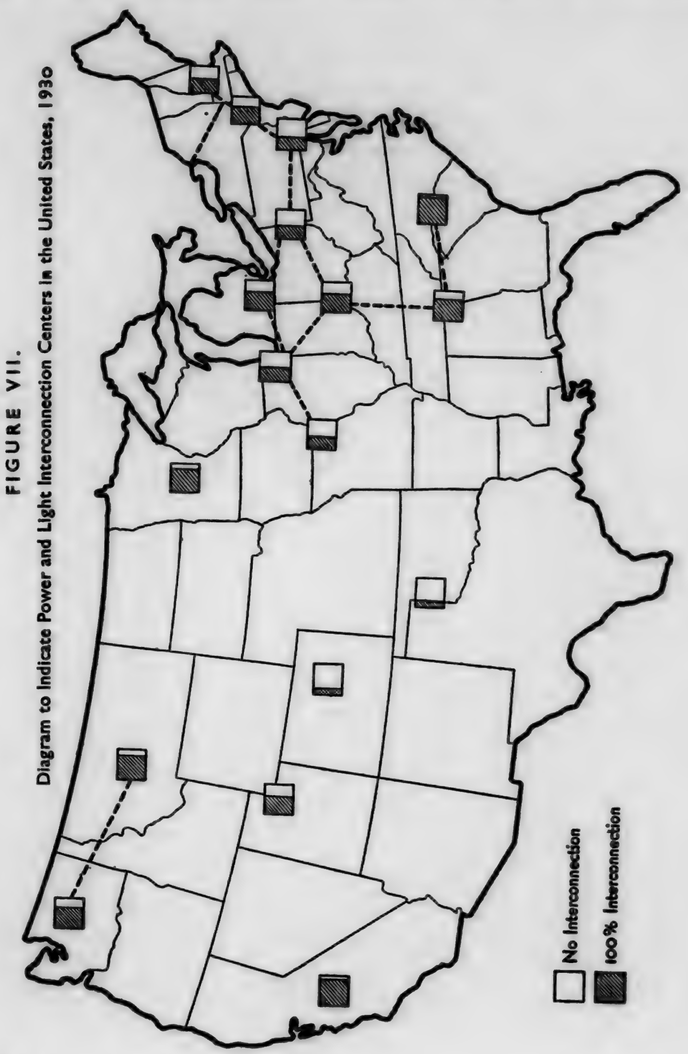
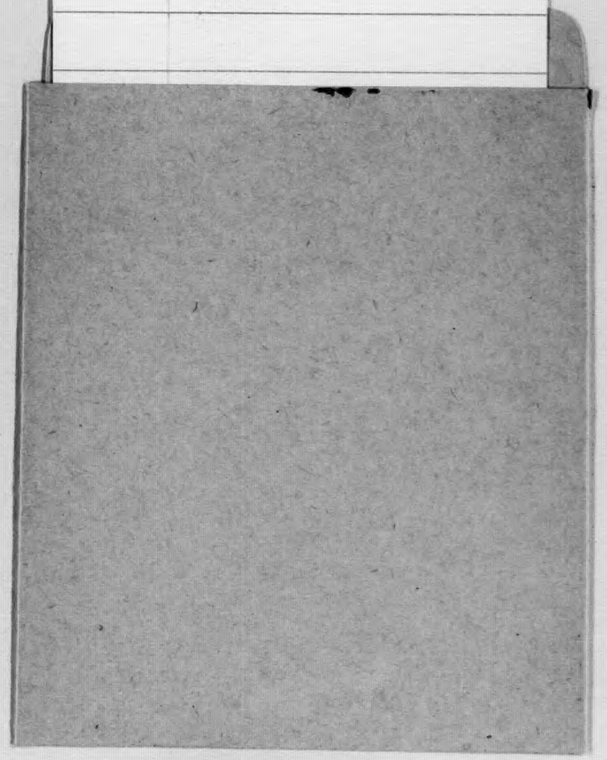


FIGURE VII.

tangible in dollars and cents, and in a uniform and constant service. It calls upon the best talent of the branches of finance, engineering, commerce, public relations and governmental co-operation for its highest development, most judicious control and maximum service to maintain the standard of living, promote the prosperity and insure the National Defense of America.

American superpower corp.

The 1930 award of the
American superpower corp.



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